Investigating Inclusion of Safety Metrics for Safe Route Determination on Pedestrian Map

By

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Dissertation submitted in partial fulfillment of
The requirements for the
Bachelor of Technology (Hons)
(Information and Communication Technology)

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CERTIFICATION OF APPROVAL

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Approved by,

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

ONG WEI HAN

ABSTRACT

To develop the safest route algorithm, it is important to research on the appropriate safety metrics that will be used to develop the safest route algorithm. Based on the researches conducted, factors such as route visibility, amount of people in the area, area near entertainment district and route condition are important in affecting safety of an area. This project focuses on how to include those factors in developing the safest route algorithm for the system and at the same time allow the ease of update/modification of the algorithm. The safest route algorithm developed for the system is tested to prove that the proposed metrics are reliable.

ACKNOWLEDGEMENT

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Besides that, I would like to show my gratitude to my friends who sometimes give me some creative ideas that help me in doing the project. I am very grateful for their valuable advices and comments.

Last but not least, it would not be possible without the support of my parents. They encouraged and assured me that I could do better.

Thank you for all the supports during this period.

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ABBREVIATIONS AND NOMENCLATURES

3G	*Third Generation Mobile Telecommunication*
CCTV	*Closed-Circuit Television*
CSS	*Cascading Style Sheet*
ERD	*Entity Relationship Diagram*
GPRS	*General Packet Radio Service*
GPS	*Global Positioning System*
GSM	*Global System for Mobile Communications*
LAN	*Local Area Network*
PHP	*Hypertext Preprocessor*
SQL	*Structured Query Language*
SRTS	*Safe Route to School*
UTP	*Universiti Teknologi PETRONAS*
WAP	*Wireless Application Protocol*
WML	*Wireless Markup Language*
XHTML MP	*Extensible Hyper Text Markup language – Mobile Profile*
XML	*Extensible Markup Language*

CHAPTER I

1. INTRODUCTION

1.1 Background of Study

For travelers, one of the top concerns is to find out the way and direction to the destination. No one would like to waste his or her time and effort trying to find the directions with a manual map. To overcome the problem, many new electrical devices such as Global Positioning System (GPS) are available in the market to assist travelers in finding the direction to the intended destination. Furthermore, the GPS devices are usually attached with shortest path algorithm to help the travelers to choose the shortest route to the destination, saving both their time and effort.

However, in this era, safety is another important factor to be considered for travelers. According to a survey conducted by Merdeka Center for Opinion Research, social problems and crime issues are the most important issue in the neighborhood. [1] And based on another survey carried out by Insurance Association, nearly 60% of the Americans think that safety and security issues will influence them on deciding which place to travel. [2]

With the increase of the crime rates and terrorism issues all over the world, there has to be some device or system that can help travelers make decisions on choosing the safe route in travelling. And for this project, it focuses on researching appropriate safety metrics for the pedestrian (travelers) and enhancing an existing final year project conducted by Ta Thu Ha by improving the safe route determination algorithm used in her project and covering a new location for the project.

1.2 Problem Statement

There is no established safety metrics to determine the safest route in an existing final year project conducted by Ta Thu Ha. To convince the users of the system, the safest route algorithm must be based on proper and established safety metrics.

1.3 Objectives of the Project

The objectives of the project are as follow:

a) Research and propose appropriate safety metrics to construct safest route algorithm.
b) Implement the metrics in finding safest route on a pedestrian map.
c) Carry out a field experiment to prove reliability of proposed metrics.

1.4 Scope of the Project

The scope of the project is to enhance safest route algorithm for handheld navigation in a pedestrian map. In the previous project done by Ta Thu Ha, the safety factor is only based on mere assumptions by considering factors such as lighting, pavement conditions and etc. Those assumptions are not tested or proven by any scientists and researchers. In this project, the research focuses on determining the appropriate safety metrics that are going to be used for the safest route algorithm. The safety metrics are based on concrete evidence and valid explanations from other knowledge sources.

The system has two types of user interface. First type of user interface is WAP based and it can be accessed through mobile phones. The second type of user interface is Web based and it is specifically designed for mobile phones that can surf the Internet using Wireless connections or 3G connections. The user interface will be improved to be more attractive and user friendly.

Moreover, since the previous final year project was using Universiti Teknologi PETRONAS (UTP) surrounding as the venue of the project, it is difficult to identify a dangerous route in this compound. Every route in UTP compound is safe and it is unlikely that crimes will occur in these areas. Thus, this project will use another venue which is the Kinta City and Tesco area in Ipoh Garden East, Ipoh as that area is a popular area where many people will use those roads. I will refer to this venue for the project as the 'location of the study' in the rest of this report.

1.5 Project Significance

The project is significant because:

a) It reduces pedestrians risk by suggesting a safer route.
b) It promotes safety awareness to the public, especially to travelers from other regions who are unaware of the safety issues of a certain place.
c) It ultimately reduces crime rates in the region.

CHAPTER 2
LITERATURE REVIEW

The main objective of the project is to incorporate the safest route algorithm to the existing system. In order to determine the safest route algorithm, appropriate safety metrics will be studied and discussed in this chapter.

2.1 Safety Metrics

2.1.1 Route Visibility

Route visibility refers to how visible a route appears to the travelers. In other words, it means how clear the travelers can see in that particular route. The main factor that affects the visibility of a road is the lighting effect. A road's visibility varies depending on the weather, light intensity from sun and street lamps as well as the existence of objects such as trees and buildings. Rainy and snowy weather can blur off traveler's vision. However, it is not a factor that could be controlled and thus it will not be included as part of the algorithm. Generally, day time will have higher visibility compared to night time. Existence of objects such as trees and buildings could reduce visibility when they obstruct the lights.

According to Transport Accident Commission, a Victorian Government owned organization which involves in promoting road safety in Victoria, one of the main issues for road safety is visibility. [3] It suggests that traffic accidents can easily happen when other road users (drivers) do not see the pedestrian. It could be due to inadequate amount of street lights and sunlight or the pedestrian is at a concealed location. The same idea is supported by American Academy of Pediatrics. In one of its articles on Pedestrian Safety, it indicates that accidents often occur in a low-light condition. And in the same article, studies of American Indian/Alaska Native have identified poor lighting as the main factor of pedestrian injury. [4]

Besides, in an article by Psychology Today on how to avoid being a target of a crime, experts advises the travelers to stay in well-lit area to make themselves less appealing to street predators. [5] Also, an article by Jackie Loohauis (2007) from Milwaukee Journal Sentinel states that travelers are more vulnerable at night and criminals like attacking in dark. [6]

Based on research projects conducted by Institute of Criminology in University of Cambridge, UK, the effects of improved street light caused the number of crimes reduced by an average of 42% in experimental area. [7] Pease, Ken (1999) from Criminal Justice Press had the similar idea that increases in street lighting generally reduce the number of crimes. [8] However, a research conducted by University of Southampton had different opinion. It concluded that there is no evidence to prove that street lighting can reduce reported crimes. However, it indicated that night time crimes had reduced in some areas for certain crime types. [9] Please refer to Table 2 in Appendix A for the results of the research conducted by University of Southampton. Although the researchers of University of Southampton disagree the fact that improved street lighting will reduce the number of crimes, they believe that it can reduce the feeling of fear.

Furthermore, an article by Ian Burrell Home Affairs Correspondent (2002) stated that improved street lightning is more effective in reducing the amount of crimes compared to the use of closed-circuit television system (CCTV). [10]

In conclusion, route visibility is one of the main factors that make travelers feel safe while walking in a particular route. Visibility of a route is greatly influenced by the lighting effect. With low visibility, car accidents and crimes are more likely to happen. Thus, it will be unsafe for the travelers to travel in a low-light condition.

2.1.2 Amount of People

Amount of people at the route is another factor that determines the safety of the path. People in this context can refer to the other pedestrians, crowd, drivers and others. Amount of people can be affected by several factors such as weather and the popularity of the area. Definitely there will be more people when it is sunny day while less people during rainy day or monsoon season. However, as mentioned above, weather is not a factor that can be controlled. Thus, it will not be included in part of the algorithm. Popularity of the area refers to how often travelers choose to use the route. Main road usually has more people while narrow short cuts have less people using.

According to an article written by Gene Turner (n.d.), a magician who adepts in sleight of hand and pick pocket, he suggested that pickpocket mostly find their victims in a crowded place. This is because people are easier to be distracted in a crowded area. [11] Also, an article by the Surveillance For Security stated that pickpockets love to target victims in a crowded area such as crowded stores or bars, bus terminals, railway stations, airports, concerts and other places that someone can easily bump into them. [12]

On the other hand, rape crimes mostly happen in area which has very few people. This is supported by Rana Sampson (2003), a national problem-oriented policing consultant. She stated cases of stranger rape (victim is raped by strangers) tend to happen in isolated areas. [13] An article from Mississippi State of Health Department (1999) in its Rape Intervention Program mentioned that rapists choose victim who is alone and not acting aware of her or his surroundings. [14]

For crimes like robbery and mugging, based on the police research group from Crime Prevention Unit in London, offenders (robbers) did not particularly mention what kind of area they choose to offend. However, many of the offenders choose to target areas around their homes due to familiarity to the area. Like other crimes, victims of the crimes are usually alone on the street. Please refer to Table 1 for a statistics of number and percentage of offences by location. [15]

Location	Number	Percentage of Sample
Street	4221	75.5
On a Bus	332	6.0
Park	285	5.0
Path/Alleyway	92	1.5
Car Park	37	0.5
Miscellaneous/Not known	648	11.5
Total	5615	100.0

Table 1: Number and Percentage of Offences by Location based on Police Research Group from Crime Prevention Unit in London

Based on the evidence above, I can conclude that amount of people at the route is another factor that determines the safety of a route. High crowd areas are unsafe as pickpockets often target their victim in those areas while other types of crimes such as rape and robbery often take place in areas with few people. In other words, a safe route is a route that has a moderate amount of people (not too crowded and not too few people).

2.1.3 Near Entertainment District

Routes that are at or around entertainment district are more dangerous compared to other routes. According to a research conducted by John K. Cochran et al (2000) from University of South Florida, they believe that entertainment districts are crime 'hot spots'. They described the Ybor City entertainment district is a crime "hot spot" due to its high concentration of bars and entertainment establishments. [16] Other evidence that supports the idea that places near entertainment district is Vancouver city. Based on the article "Vancouver Violent Crime Drops" from CBC News, many crimes such as sex offences, murder, assaults and robberies occurred in Vancouver city. The city police chief, Jim Chu suggested that the victimization of people could be due to "people have had too much drink". [17]

Based on a statistics by the British Crime Survey and Police Recorded Crime, around 50% of the victims think the criminals were drunk when they were being victimized. [18] Please refer to Figure 1 for a statistic done by Anderson ZA (2004) from Trauma and Injury Intelligence Group on Alcohol-related Assaults by age. Based on the Figure 8elow, many cases are related to alcohol consumptions and most of them occured in areas that are around pubs and nightclubs. [19]

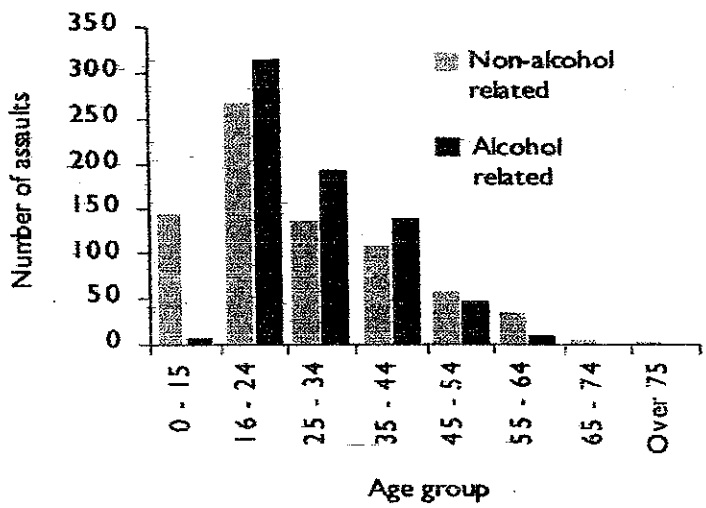


Figure 1: Alcohol-related Assaults by Age

In conclusion, routes at or around entertainment districts are generally more dangerous than other routes. The pubs and nightclubs in entertainment districts encourage the consumption of alcoholic drinks. People who are drunk are more likely to commit crimes. Therefore, crime rates are higher in areas in and around entertainment districts which makes those areas unsafe for pedestrians.

2.2 Other Similar Applications

2.2.1 The Safe Route to School (SRTS) Program

SRTS Program is a program launched in United States with its primary funding aid comes from U.S. Department of Transportation's Federal Highway Administration.[20] The missions of the program are listed below:

1. Make walking and bicycling safe ways to get to school
2. Encourage more children to walk and bike to school

This program is believed to be able to reduce the number of children hit by cars, reduce congestion around schools and reduce air pollutions. [21]

As part of the SRTS Program, Christopher J. Seeger, ISU Extension landscape architect and associate professor of landscape architecture gives his contribution to the program by developing a web-based mapping tool that could combine Google Maps with information of school districts. With data gathered by SRTS Program, the map can identify the location where the children live, the routes they take to go to school and any obstacles that may impede walking and biking. [22]

Although SRTS Program has tried to incorporate safety metrics in its system, it is a very different application compared to this project. SRTS Program focuses on the safety of children who are walking and cycling to school while this project targets the general pedestrians. Furthermore, SRTS Program emphasizes mostly on traffic safety for the children while this project covers not only traffic safety but other issues such as crimes.

2.2.2 Ride the City

Ride the City is an application that helps cyclist to choose a shortest and safer route to cycle. It has similar idea with this project which provides both shortest route and safest route options to the users. Ride the City is based in New York City and will be further expanded in the future.

Ride the City safety metrics for cyclist is based on two characteristics [23]:

1. Excludes roads that are not meant for biking.
2. Locate routes that maximize the use of bike lanes and greenways.

There are arguments on the safety metrics of Ride the City application. Some users doubt the safety metrics used by the application is not 'safe' enough. By having the characteristics mentioned above does not really convince the users that the route is safe. Therefore, as a relatively new application, there are still many weaknesses Ride the City is trying to improve on.

Similar to SRTS Program, Ride the City focuses mostly on traffic safety rather than other issues such as crimes. Another distinct difference from this project is Ride the City targets only cyclists while this project puts its main attention on pedestrians.

2.3 Mobile Application Technology

2.3.1 Wireless Markup Language (WML)

To understand WML, we first have to know what Wireless Application Protocol (WAP) is. WAP is a combination of several protocols and a complete network architecture which is mainly used for wireless content delivery. It has a set of architecture that based on OSI Model which is shown below: [24]

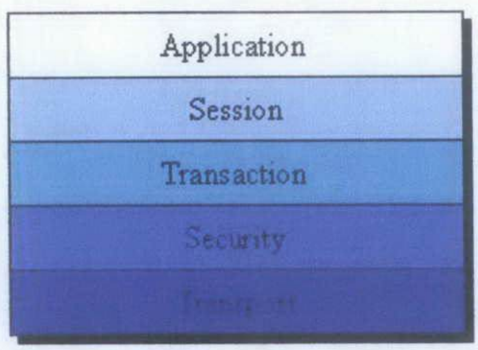


Figure 2: The WAP Model

WML is one of the components found in WAP. It is the markup language used to specify how the Internet content can be displayed to a WAP browser. Similar to HTML in common web browsers, WML serves the same purpose in WAP browsers. The difference is that WML requires less memory and processing power to support a browser. In the earlier generation of mobile phones that support connection to the Internet, most mobile phones are using GPRS in order to connect to the Internet. Due to the speed limitation of GPRS, WML strives to be a more viable language to be used as it removes the unneeded features of HTML and it has conventions that make the pages easier to parse.

Similar to HTML, WML supports tag-based syntax such as @lta> and @ltp> (<a> and <p> in html). It also has a stricter conformance to standard compared to HTML. For example, an open tag has to be closed by an end tag. [25]

2.3.2 Extensible HyperText Markup Language Mobile Profile (XHTML MP)

XHTML MP is the markup language defined in WAP 2.0, the latest mobile service specifications. XHTML MP is part of Extensible HyperText Markup Language (XHTML), a stricter version of HTML.

The main objective of XHTML MP is to combine the technologies of mobile Internet browsing and World Wide Web technology. Before the introduction of XHTML MP, technologies of mobile Internet browsing and World Wide Web technology are separated in a sense that WAP developers make use of WML while web developers use HTML/XHTML with Cascading Style Sheet (CSS) to build websites. [26]

The introduction of XHTML MP provides two significant advantages:

1. Wireless Internet application now can have a nice user interface with better presentation control through WAP Cascading Style Sheet. WAP CSS can be now used together with XHTML MP and it allows the developers to easily change and 'style' their presentation of XHTML MP pages.
2. Both web and wireless version of the Internet sites can be developed using the same technology, which is XHTML MP. In other words, it means web browsers can be used to view WAP2.0 application during the prototyping and development phases.

2.3.3 Comparison between WML and XHTML MP

Both WML and XHTML MP have been described in previous section. The similarities of both Markup Language are:

1. They are designed for mobile application with small screens and limited presentation capabilities (compared to computer web browser)
2. They require less memory and processing power
3. They strictly adhere to XML language rules

However, the difference between these two can be seen in Table 2 [27]:

	WML 1.x	XHTML Mobile Profile and CSS
Standardization body	Standard developed by WAP Forum	Standard developed by W3C and adopted by OMA
Content displaying in devices	Content and layout defined in same document, which has to be separately tailored for each device	Content and layout defined in separate documents, thus same content renders differently using different style sheets
Content encoding	Content needs to be binary coded	No content encoding required
Document layout control	Basic	Advanced layout control with CSS
Color control support	Only color images but no color control for fonts, background, borders, etc.	Full color control support for fonts, backgrounds, borders, etc., with CSS on color devices

Table 2: Differences between WML and XHTML MP with WAP CSS

In short, the main difference between WML and XHTML MP is the presentation control and content portability. For further information regarding to the relationship between the markup languages and the evolution of mobile browsing, please refer to Appendix II. [27]

CHAPTER 3
METHODOLOGY

3.1 Methodology Selected

3.1.1 System Development Methodology - Prototyping

Prototyping Methodology is used for this project. The main benefit of using this methodology is because it quickly provides a preview of how the exact system looks like. And with the prototype, the system can be improved if some parts of the system are not satisfactory. The goal of using this methodology is to quickly come up with a prototype so that the prototype can be compared if it meets the objective of the project. If the prototype does not meet the objective of the project, enhancements and modification can be done to the system. Furthermore, the system requires a lot of testing to validate the safest route algorithm. Therefore, it will be good to use prototyping methodology to do the project. Figure 2 below shows a model of prototyping based methodology. [28]

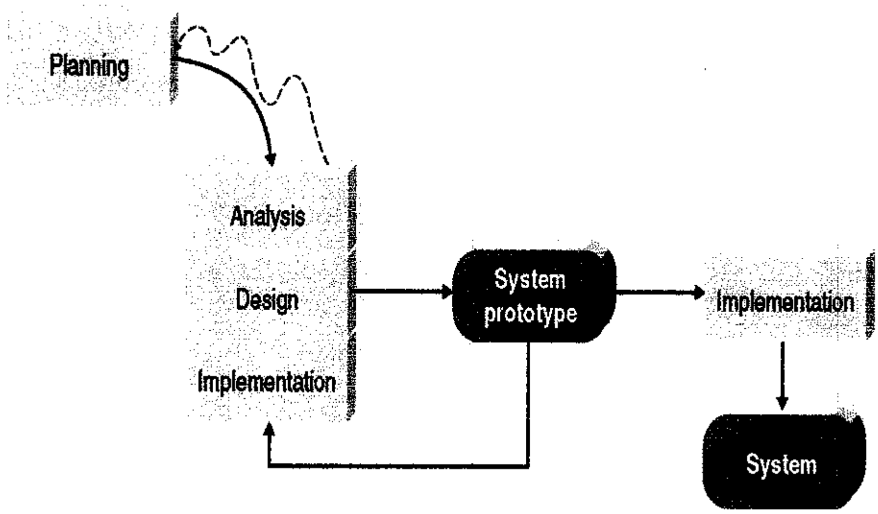


Figure 3: A Prototyping Based Methodology

Phase 1: Planning

Planning phase is the most important phase of system development life cycle. It is initiated by identifying the problems, the solutions of the problems and the objectives of the project. A short feasibility analysis is carried out to make sure the project is economically and technically feasible. In this phase, the scope of the project is clearly defined to prevent scope creep.

Phase 2: Analysis, Design and Implementation

Phase 2 is a combination of analysis phase, design phase and implementation phase. Analysis phase focuses on determining the safety metrics needed by the safest route algorithm. To figure out the safety metrics, researches have to be conducted to understand the safety concerns of the pedestrians of the road. Besides that, it is important to know what kind of user interfaces is suitable for this system. The project will be reviewed again to make sure that it is still feasible. If it is not feasible, the planning phase has to be restarted to modify the objectives or limit the scope of the project.

If the project is still feasible, design phase will be started. It mainly emphasizes on the design of the databases. The relationship between each tables and the fields of the tables have to be modified to incorporate the safest route algorithm. There are few factors that have to be considered while designing the database. Some of the factors are complexity and size of the database as it will impact the non-functional requirement of the project such as performance. Another main focus of the design phase is designing the user interface of the system. The user interface has to be interesting and attractive to meet the objectives of the project.

Implementation of the system will begin once analysis and design are completed. This is the phase when the system is coded to include safest route algorithm and the user interface is modified. Testing will be conducted to ensure the system is free of major bugs that could cripple the system.

Phase 3: Compare the Prototype with Predefined Objectives

After testing the prototype, the prototype will be assessed to verify if it meets the objectives of the project. If the prototype is not align with the objective, the project will either move backward to phase 2 to refine the analysis or design or reset to phase 1 to begin its planning phase again. However, if the prototype meets the requirements of the project, implementation phase will be carried on to transform the prototype into the real system. Testing and quality assurance will be performed before releasing the system to make sure the system meets the requirement and free of major errors.

3.1.2 Research Methodology

In order to complete the project, it is important to perform researches and gather information. The research methodologies that are used in this project are shown below:

Observation on Site

This project will cover a new area which is the Kinta City and Tesco area in Ipoh Garden East, Ipoh (which will be known as location of study in the rest of the report). In order to obtain information on the routes and important landmarks in that area, observation on the site is being carried out. Another aim of carrying out observation is to check the road conditions and any obstacles pedestrians might face while using the routes. Besides that, observation on site can obtain some information on qualitative factors such as traffic intensity of the routes. Google Map and Google Earth is being used to help and make the observation process easier.

Distributing Questionnaire (Survey)

A set of questionnaire will be distributed to the people who go to that area mainly to gather information regarding to how they think about the safety of the routes in that area and the safety metrics that they consider the most important. The questionnaire is used to validate the information gather through observation as well as to get more information that can help completing the project.

Statistical Methods

Statistical calculations will mainly be used on the results of the questionnaires. It helps in analyzing the result of the questionnaires to provide clearer and more meaningful information. The information will be represented in a chart or diagram form to give a better picture that is more understandable.

3.2 System Analysis

3.2.1 System Architecture

This project will be using the same architecture as the previous existing project. Thus, the architecture used for this project is tiered client-server architecture. The server will be running on Apache support by SQL server as the backend database. The server can be accessed by both clients who run on PC platform as well as mobile clients who use mobile devices like cell phones and personal digital assistant (PDA). Clients who run on PC platform can access directly to the service at the server while mobile clients can access the service through wireless LAN or GSM/GPRS/3G network. [29]

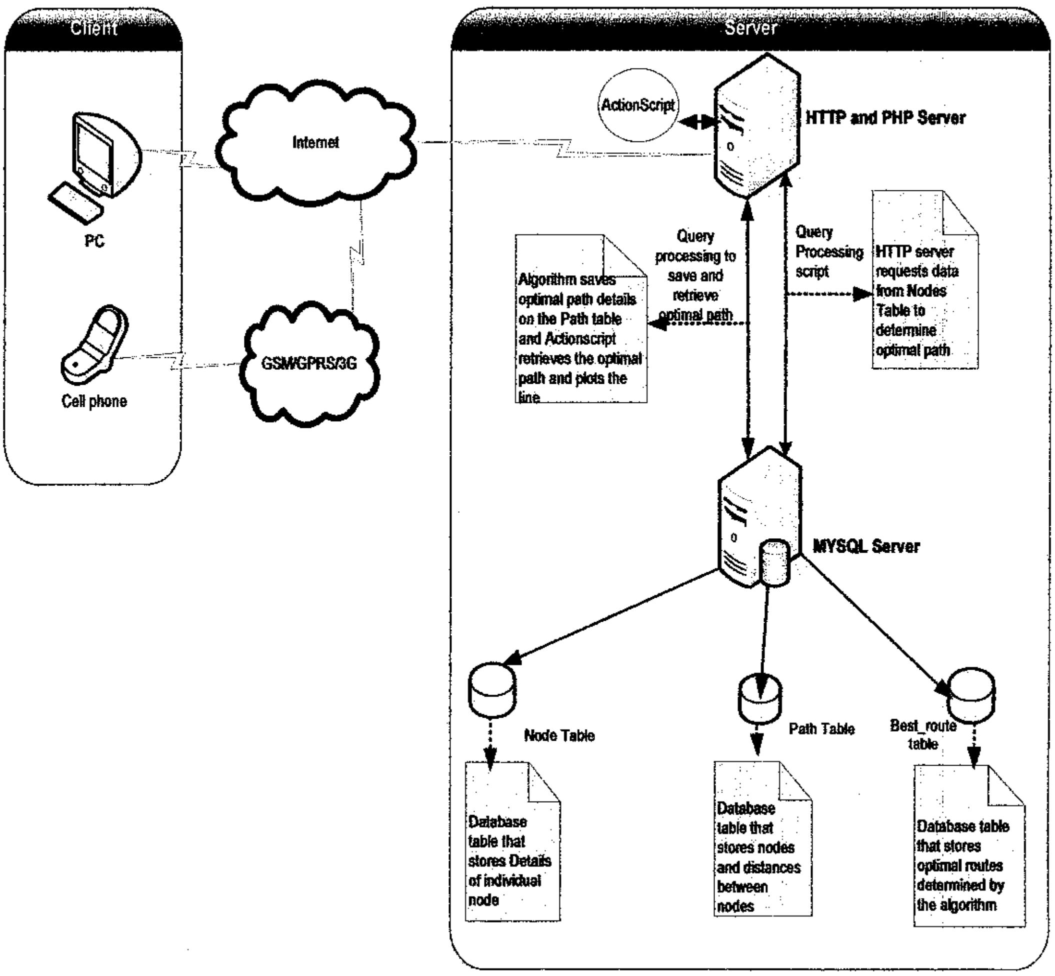


Figure 4: System Architecture

3.2.2 Use Case Diagram

The interaction between the user and the system is shown in the Use Case Diagram below.

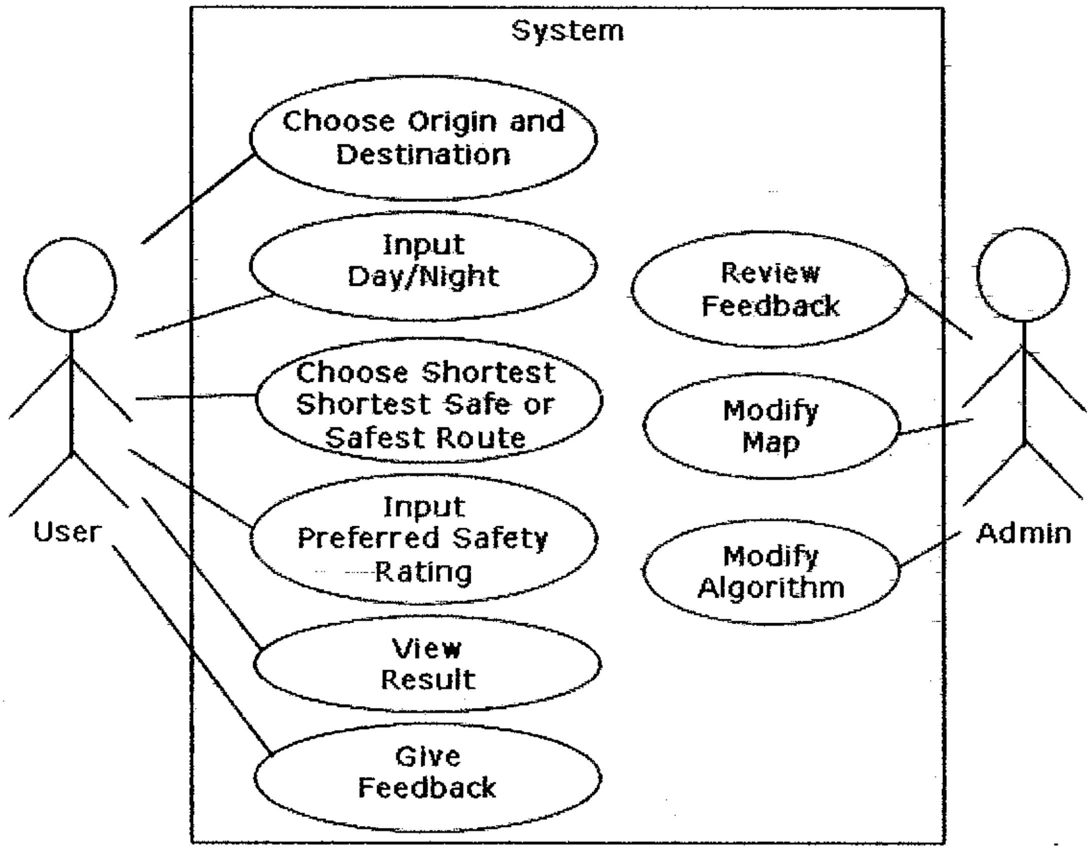


Figure 5: Use Case Diagram

There are 2 main actors in this system: the user and the administrator. Users can have 6 different ways of interaction. The user has to give input to the system by choosing origin and destination. Next, the user has to provide information to the system whether it is day/night as it affects the result of the safest route. Besides this, the user has to specify the system to suggest the shortest route, shortest safe route or the safest route. If the user choose shortest safe rout, the user has to input his or her preferred safety rating. The user can view the result (the route) from the system.

Since the map and the safety metrics can have changes from time to time, users will be the main source of information for those changes. Users can give feedbacks to the system for three types of purposes: complains, suggestions, map changes. From these feedbacks, the administrator can review the user feedbacks and make modification on the algorithm as well as the map by altering the fields in the database.

3.2.3 Activity Diagram

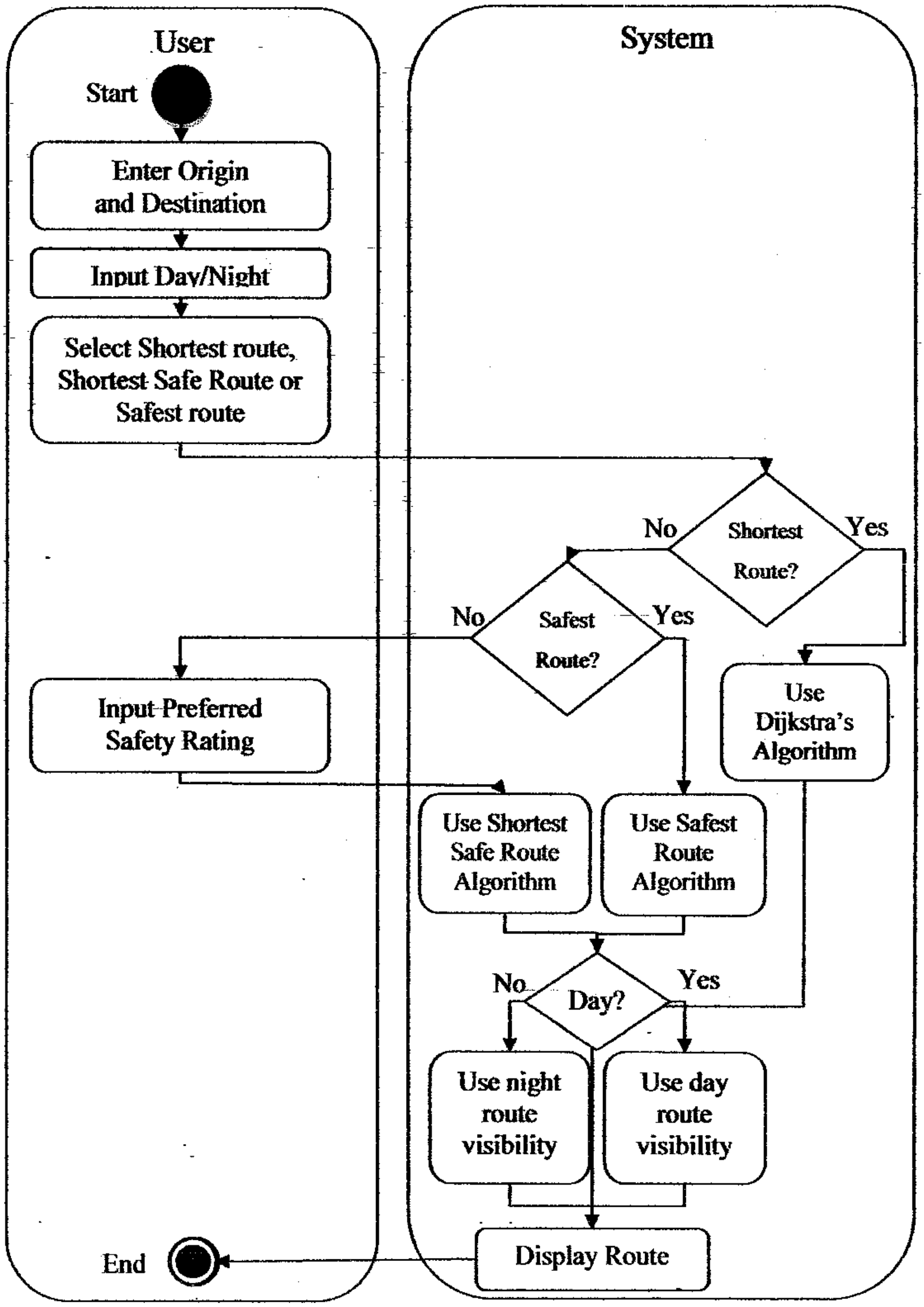


Figure 6: Activity Diagram For Finding Route

Find Route

To use the system, firstly, the user has to connect to the internet through their mobile phones. Then, the user will enter his/her origin as well as destination into the text fields provided. The user also has to specify whether it is day or night. The user can choose whether to select the shortest route, shortest safe route or the safest route. The system will then generate the route based on the type of routes chosen. Dijkstra's algorithm will be used if shortest route is selected; shortest safe route algorithm will be used if the shortest safe route is selected; safest route algorithm will be used if safest route is selected by the user. If the shortest safe route is selected, the user has to enter his or her preferred safety rating. Due to the visibility of routes is different from daytime and nighttime, thus different parameters will be used for the algorithm based on user input. After generating the route based on the algorithm, the routes will be displayed to the user.

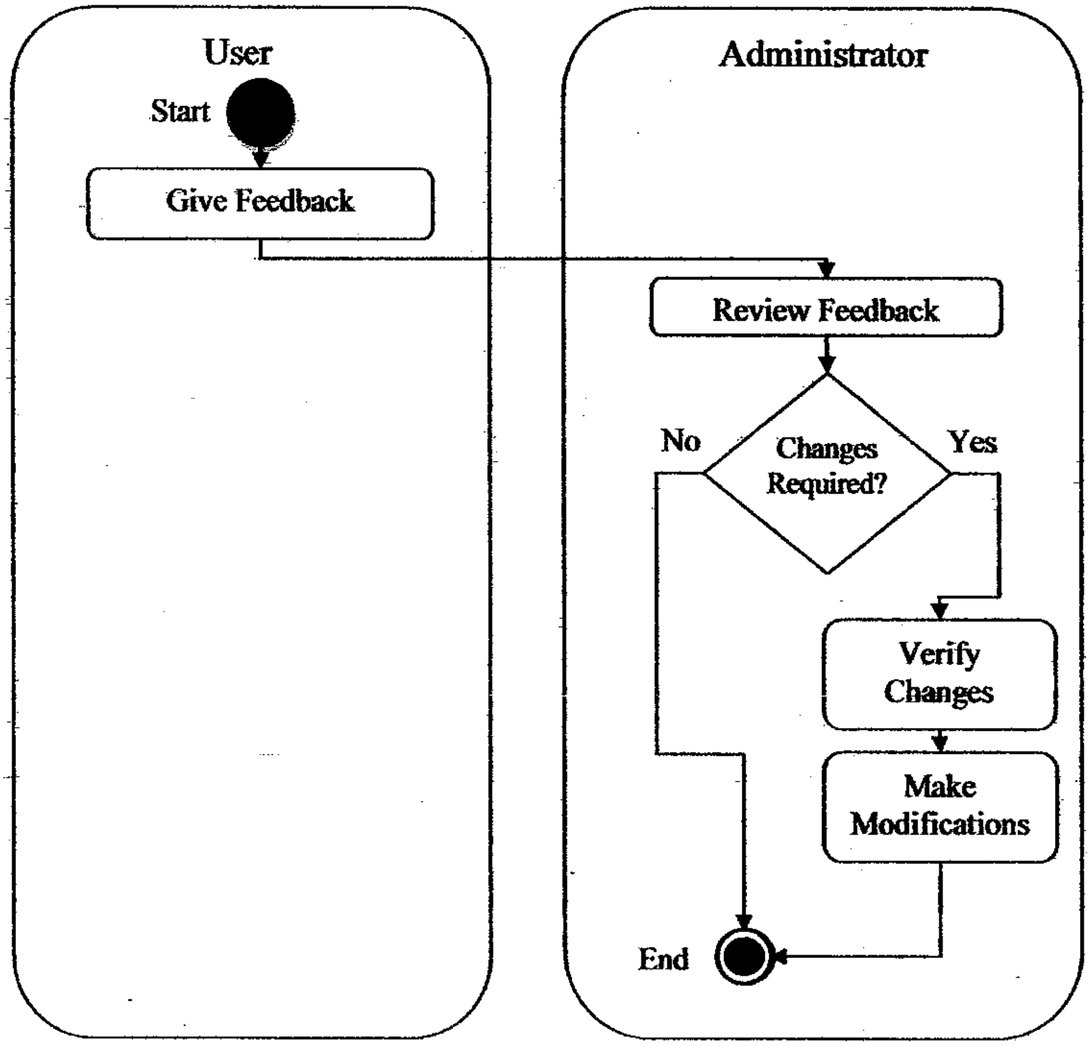


Figure 7: Activity Diagram for Updating/Modifying

Update Map/ Modify Algorithm

Users submit feedbacks through the system. The administrator will review the feedbacks. Based on the content of the feedback sent by the users, if the system requires a change, then the administrator has to verify the changes by gathering more information/evidence and make modifications according ly.

3.2.4 Entity Relationship Diagram (ERD)

The database of the system is designed based on the safety metrics of safest route algorithm. The design of the database is shown in the ERD below:

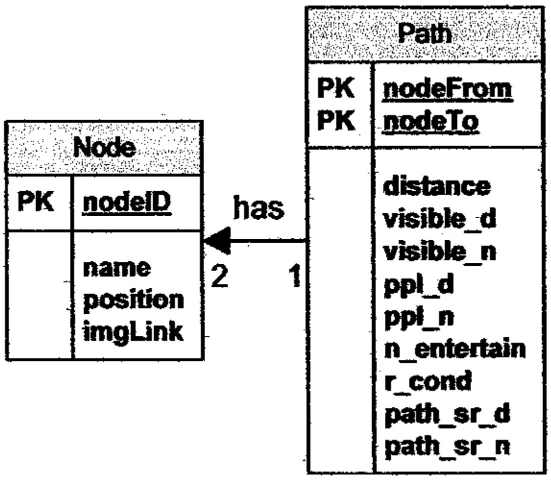


Figure 7: Entity Relationship Diagram

The information related to the nodes, paths and feedbacks will be stored in a relational database management system. The details of each table will be discussed below:

- Table "Node" stores information related to the node with nodeID serves as the identifier of each node.

- nodeID – identifies a node
- name – name of the node/location
- position – the exact position of the node on the globe
- imgLink – the address that links to the image of the node

- Table "Path" stores information related to the path with nodeFrom and nodeTo as the primary and foreign keys that relate to nodeID in table "Node".

- nodeFrom & nodeTo – identify a path
- visible_d – visibility of the path at daytime

- visible_n – visibility of the path at night
- ppl_d – amount of people at daytime
- ppl_n – amount of people at night
- n_entertain – determine if the path is near entertainment district
- r_cond – the route condition of the path
- path_rr_d – the risk rating of the path on daytime
- path_rr_n – the risk rating of the path at night

- Table "Feedback" stores information related to the feedbacks given by the users.

- fID – identifies a feedback submitted by user
- type – the type of the feedback (complain, suggestion or map changes)
- message – the content of the feedback
- user – the name of the user (optional)
- email – the email of the user (optiona)

3.3 Tools and Techniques

The following tools and techniques are used in developing the project:

Apache - An open source software that serves as a web server in this project. The primary goal of using Apache is to implement the web service of the system.

Hypertext Preprocessor (PHP) - A popular server-side scripting language that makes the web page to be more dynamic. It allows the user to interact with the web server through web pages.

MySQL – An open source database that is flexible and easy to use. It will be used to store data such as the nodes of the map and some safety metrics attributes.

Notepad++ - A free source code editor that supports few programming languages in Microsoft Windows environment. It provides a programming environment that is more convenient and eases the coding process.

Adobe Photoshop CS2- A graphic-editing software that can create and edit images. It is used in the project to design images that will be used in the user interface.

FastStone Capture – An application that eases the effort of taking screenshot. It also provides basic graphic-editing feature.

Mobile Emulator - The emulator will be used to simulate the process of using the system in a mobile device environment during the testing phase.

Google Earth – A free application that provides Google Map service. It provides some additional functionality that Google Map (in web browser) does not offer and thus gives better flexibility.

Openwave v7 Simulator – A phone simulator software that simulates how a user can interact with the server using phones.

CHAPTER 4
RESULT AND DISCUSSION

4.1 Survey Result

The objective of doing the survey is to validate the information gather through observation as well as to get more information that can help completing the project. 33 people from different gender, race, age groups and background (including UTP students, residents in Ipoh, employees working in location of study) had taken the survey. The survey seeks to find out how people think about the safety in location of study to the pedestrians. Besides this, the survey aims to obtain information on the frequency of people going to the area and the importance and criticality of the safety metrics in affecting the safety of a route. The survey also has an open ended question that attempts to get additional information on what other safety metrics that will affect the safety of a route.

4.1.1 Frequency of People Going to the Location of Study

Based on the survey, the frequency of people going to the location of study can be shown in a pie chart below (Please refer to Figure 7). There are 63% of the people who took the survey go to that area at least few times a month while 24% people go to that area once a month. Only 12% of the people who undertook the survey rarely go to that area. The result shows the popularity of that area and therefore it validates the need of doing this project.

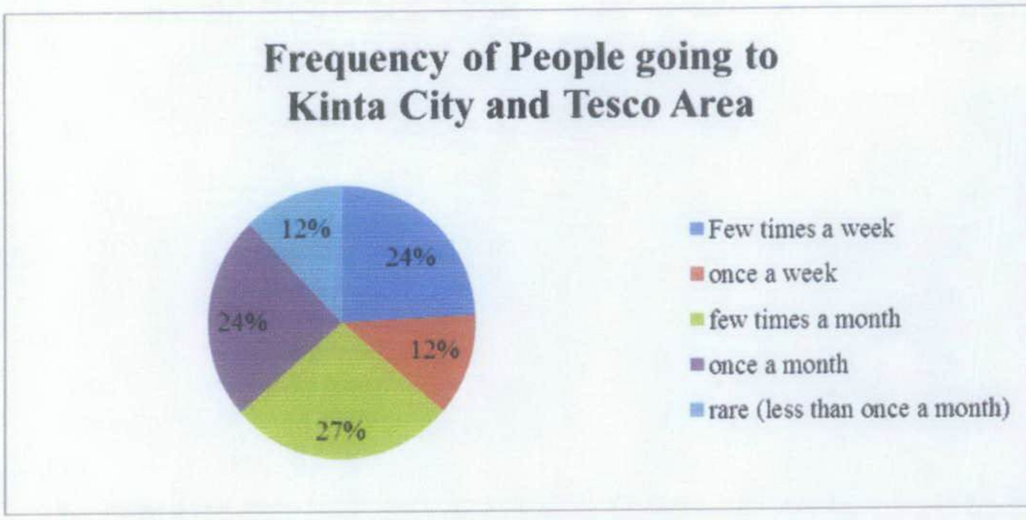


Figure 8: Frequency of People going to Location of Study

4.1.2 Safety of the Location of Study to Pedestrians

Please refer to Figure 8 for the result of the survey. The majority of the people (58%) who took the survey think the area is dangerous to the pedestrians while the other 42% think the area is not dangerous to the pedestrians. Although this result does not prove whether the area is safe or dangerous, it indicates that some people think the area is not safe and thus they might be interested to know the safest route to be used when they are travelling from one place to another place in that area.

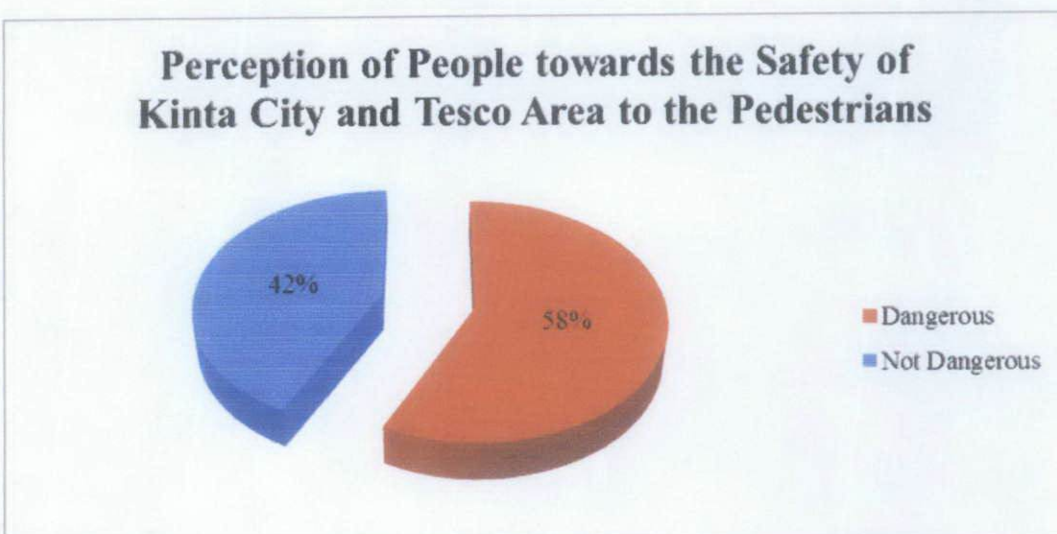


Figure 9: Perception of People towards the Safety of Location of Study

4.1.3 Importance of Safety Metrics in Affecting the Safety of a Route

Based on the result of the survey (please refer to Figure 9 below), most people think route's visibility is the most critical factor in affecting the route safety while some people think the amount of people and area that is near entertainment district does not really affect the safety of route. However, overall survey result indicates that all three safety metrics are important factors that affect the safety of a route. The survey result will serve as a reference in constructing the safest route algorithm for the system.

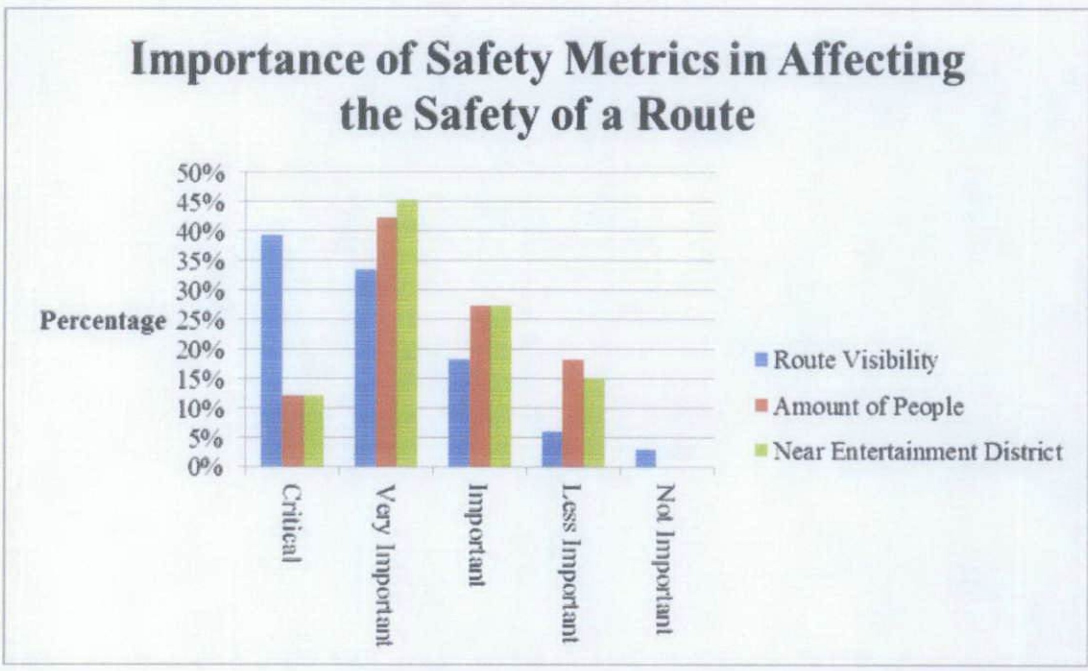


Figure 10: Importance of Safety Metrics in Affecting the Safety of a Route

4.1.4 Other Safety Metrics that affect a route's safety to the Pedestrians

Based on the survey result, the following are some of the factors that affect route safety towards pedestrians given by the people who took the survey.

Driver's Attitude – The attitude of a driver who is driving on that route influences the route safety. The route will be more dangerous if there are many reckless drivers who drive their cars in a very fast speed.

Crime Rate – The crime rate of the route has great impact on the safety of a route as crimes usually occur at the similar areas. The crime rate can serve as a reference to determine how dangerous a route is.

Route Condition – The condition of a route can be a route without road pavement, a route with many holes and drains, a route that encourages car drivers to drive fast or a proper paved road. A well condition route poses no threat to the pedestrians while a poorly conditioned route may cause pose some risks to pedestrians in terms of involving accidents, encountering criminals or causing self injury due to carelessness.

Near to Police Station – If an area that is near entertainment district is more dangerous, t an area which is near to police station could be safer. Criminals usually will not choose to carry out the crimes in a place near police station because it exposes them to the risks of being caught easier. Similar to the drivers, they tend to drive in a safer manner in an area that is near to police station.

Amount of Cars – Besides the amount of people, high amount of cars can be one of the factors that increase the accident rate of a route. In other words, pedestrians will have higher risk of encountering accidents in a high traffic area.

4.2 Safest Route Algorithm

The safest route algorithm will be constructed in this section.

4.2.1 Safety Metrics to be Included

To determine the safest route algorithm, the safety metrics for the algorithm have to be identified. Based on the survey result, please refer to Table 3 for list of safety metrics that are included and excluded in the algorithm.

Included in the Algorithm	Excluded in the Algorithm
Route Visibility	Driver's Attitude
Amount of People	Near To Police Station
Near Entertainment District	Amount of Cars
Route Condition	Crime Rate & Accident Rate

Table 3: List of Safety Metrics

The reasons for some safety metrics that are excluded in the algorithm are discussed below:

Driver's Attitude – Attitude of a driver does not depend on a certain route. In other words, there is no direct relationship between a driver's attitude and a route. Attitude of a driver varies based on each driver's emotion, social background and personality. There is no proper method to determine how a driver behaves in a certain route. Thus, driver's attitude will not be considered in the algorithm.

Near to Police Station – This safety metric might impact the safety of a route. However, there is no nearby police station in the location of study. To avoid scope creep, this safety metric will be ignored as for this project.

Amount of cars – It is difficult to determine the amount of car will make a route safer (decrease crime rates) or more dangerous (increase accident rate). Due to the ambiguity of this safety metric, it will not be considered in the algorithm as for this project.

Crime Rate & Accident Rate – It is discussed in detailed in next page.

4.2.2 Variation of Safest Route Algorithm

Ideal Safest Route Algorithm

It is ideal to include crime rate and accident rate of a route into the algorithm. However, the challenge of including the safety metric into the algorithm is that information is not available. The information of the crime rate/accident rate on a specific route is not recorded in any institution including the police station. Most of the time, the information of the crime rate/accident rate covers a whole area instead of a specific route. Therefore, the crime rate and accident rate of a route will only be included into the algorithm in an ideal situation where the information is available (in other areas or in the future)

Modified Safest Route Algorithm Based on Assumption

Different from the ideal safest route algorithm, an assumption is made in imperfect safest route algorithm. If a specific area has a high crime and accident rate, all nearby routes are assumed to be more dangerous. This algorithm will be used if crime rate and accident rate for a certain area can be obtained.

Imperfect Safest Route Algorithm

Imperfect Safest Route Algorithm does not take crime rate and accident rate into consideration. This algorithm will be used if the information of crime rate and accident rate for a certain area cannot be obtained or not detailed enough.

For this project, imperfect safest route algorithm will be used. This is because the information of crime rate and accident rate obtained from the police institution covers the whole area of the location of study. In other words, the safety of all routes in the location of study is affected by the same information of crime rate and accident rate obtained. If modified safest route algorithm based on assumption is used, all routes in the location of study will share the similar safety/danger level as the information given is not detailed enough to distinguish the safety/danger level of the sub-areas in the location of study. Therefore, since the safety level of all routes in the location of study cannot be differentiated by the information (crime rates and accident rates) given, imperfect route algorithm will be used.

4.2.3 Details of Each Safety Metrics

Safety Metrics	Parameter	Description
Route Visibility Weight = 30%	r_visible_d r_visibie_n	Is the route visible on day time? Answer: - Yes, enumerated by 0 - No, enumerated by 1 Is the route visible at night? Answer: - Yes, enumerated by 0 - No, enumerated by 1 Note: Only one parameter will be used based on daytime/night.
Amount of People Weight = 25%	ppl_d pp_n	Is the area over crowded, crowded or has very few people? Answer: - Very high amount of people (> 600 people in 1 hour), enumerated by 1 - Acceptable amount of people, (<600 and >12 people in 1 hour) enumerated by 0 - Very few people, (<12 people in 1 hour) enumerated by 1
Near Entertainment District Weight = 25%	n_entertain	Is the route near entertainment district? Answer: - Near (adjacent point to entertainment district), enumerated by 1 - Not near (not an adjacent point to entertainment district), enumerated by 0
Route Condition Weight = 20%	r_cond	Is the route condition good? Answer: - Well-paved, enumerated by 0 - Many holes and drains, enumerated by 1 - Encourage Drivers to drive fast, enumerated by 1

Note: Weight of each safety metrics are based on the their importance in affecting the route safety (from the survey result)

Table 4 : Details of Each Safety Metrics

4.2.4 Algorithm

The system allows 3 different algorithms to be used:

1. Shortest route algorithm – does not take safety into consideration
2. Shortest safe route algorithm – user specifies a safety rating that will be used to filter the paths that satisfy user's safety rating. The shortest route will be generated from the list of paths that fulfill user's preferred safety rating.
3. Safest route algorithm – The system will generate the route that has the highest safety rating (and the shortest of the safest routes if there are more than one route have the highest safety rating)

Shortest route algorithm was implemented in previous projects and thus it will not be discussed in this section.

By referring to algorithm proposed by Mr. Yew, supervisor of this project (please refer to Appendix III for the full algorithm), the shortest safe route algorithm will be based on his algorithm with some modifications on the safety metrics.

Shortest Safe Route Algorithm

The algorithm will traverse all the paths in the database. Based on user's preferred safety rating, it will add all the paths that fulfill the user's safety rating into fitPath_list. At the end of the traversal, it will choose the shortest route based on the paths in the fitPath_list. In other words, this algorithm ignores the paths that have risk rating higher than user required. If none of the routes fulfill the user preferred safety rating, it will print a message to the user indicating that no available route that can fulfill his/her requirement. The algorithm steps are as follows:

Step 1:

Create empty fitPath_List

Step 2:

User will specify the preferred safety rating: **very safe** (risk rating = 0) , **safe** (risk rating is a value more than 0 and less than 0.25) or **normal** (risk rating is a value more than 0.25 and less than 0.5).

Step 3:

System establishes connection to database. The algorithm initially traverses through all paths $P = \{P_0, P_1, P_2, ... P_n\}$ to retrieve their risk rating. The risk rating of each path, path_rr is computed by the summation of the multiplication of safety metrics and their weight:

For daytime,

path_rr_d = 0.3*r_visible_d + 0.25*ppl_d + 0.25*n_entertain + 0.2*r_cond

For nighttime,

path_rr_n = 0.3*r_visible_n + 0.25*ppl_n + 0.25*n_entertain + 0.2*r_cond

Note: the value of path_rr is computed beforehand and stored in database to reduce processing time.

Step 4:

Compare the value of path_rr (path_rr_d or path_rr_n) towards the user's preferred safety rating.

If preferred safety rating == "very safe", add path that has path_rr ==0 into fitPath_List

If preferred safety rating == "safe", add path that has path_rr <=0.25 into fitPath_List

If preferred safety rating == "normal", add path that has path_rr <=0.5 into fitPath_List

Step 5:

Check if there is more path in database, If yes, go back to step 3. Else, pass fitPath_List to the shortest route algorithm.

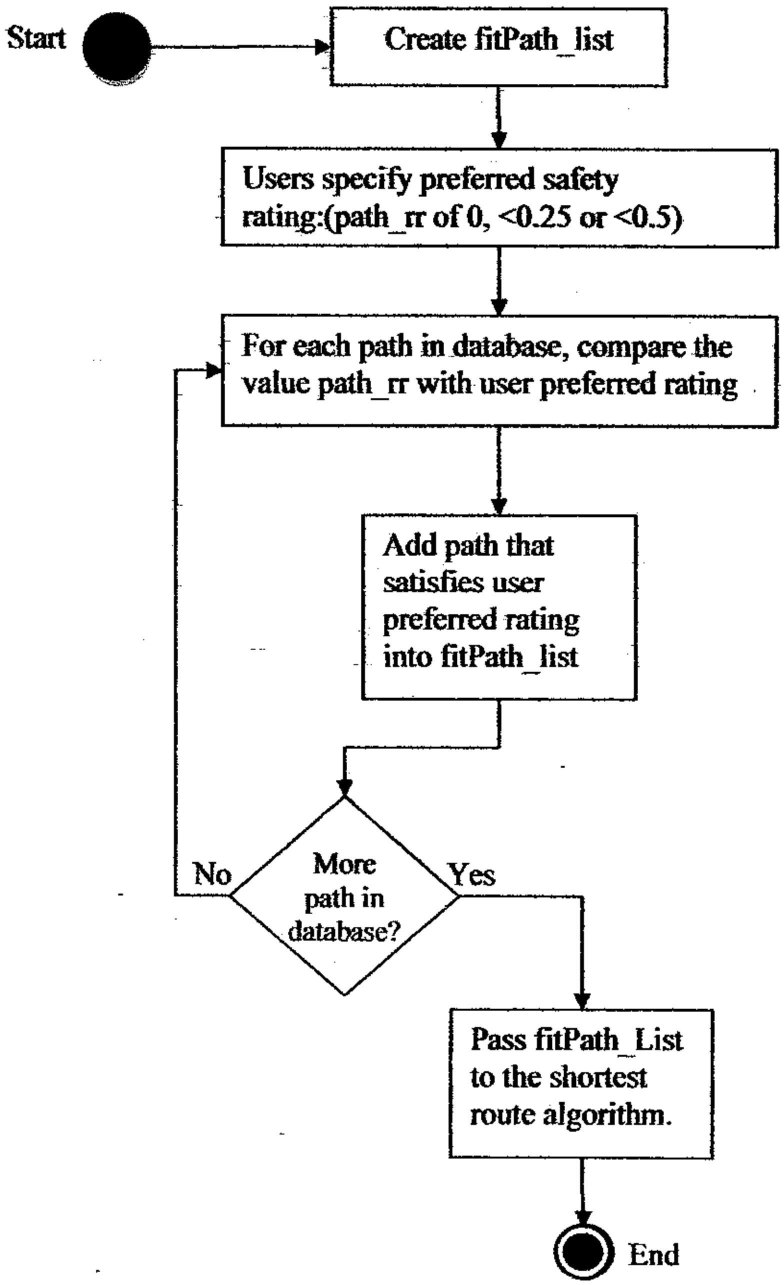


Figure 11: Flow Chart for Shortest Safe Algorithm

Safest Route Algorithm

The algorithm will traverse through all the paths in the database and choose the route that is safest (lowest risk rating).

Step 1

Label source node's risk_rating = 0. Insert source node into an array, visited_node_array

Step 2

System establishes connection to database. For each unvisited node, label node's risk_rating = path_rr of the unvisited node + path_rr of the newly visited node (node that is newly inserted into visited_node_array).

If the unvisited node's risk_rating is already labeled,

Set the node's risk_rating = MIN(previous risk_rating, current computed risk_rating)

Step 3

Link unvisited node to newly visited node by:

unvisited node -> previous = newly visited node

Step 4

Insert the node with lowest risk_rating into visited_node_array

Step 5

Check if there is any unvisited node: If yes, go back to step 2. Else the algorithm returns the linked list of safest nodes from the destination node.

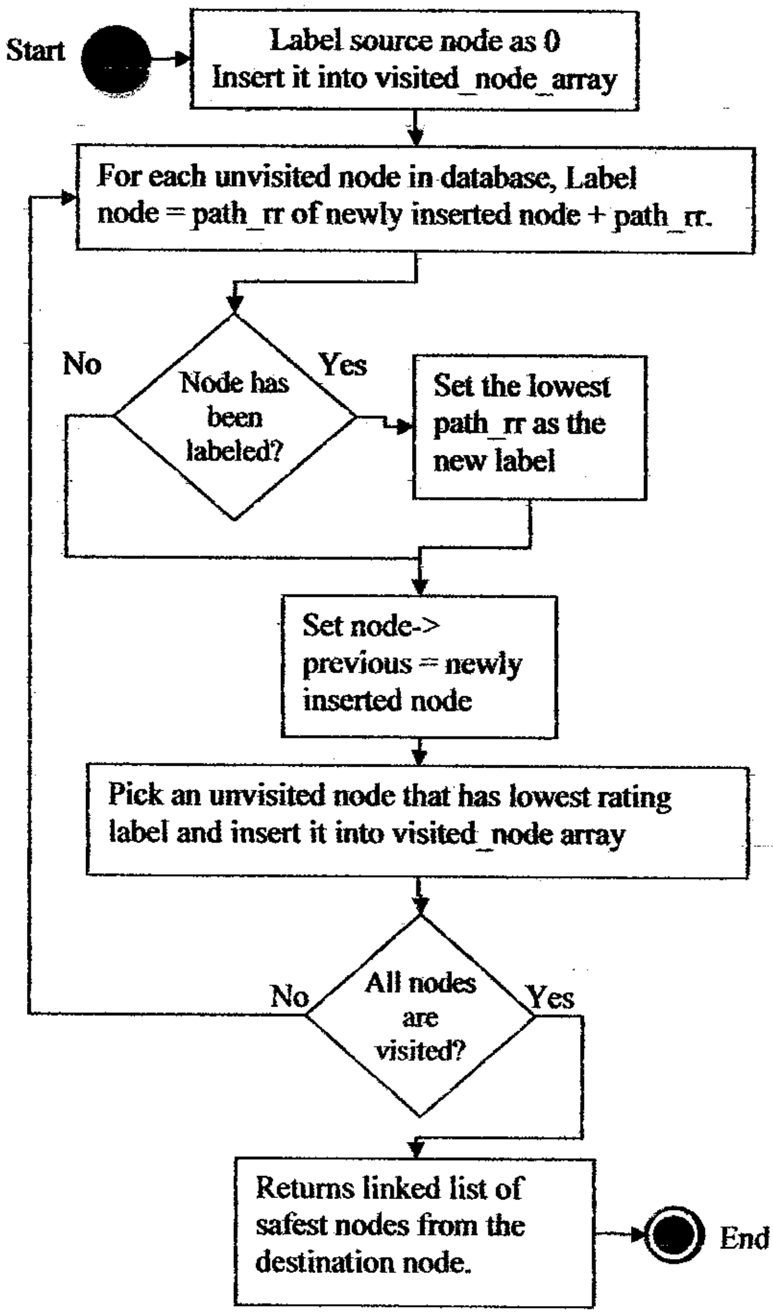


Figure 12: Flow Chart for Safest Route Algorithm

4.3 Location of Study

Information related to the location of study will be discussed in this section.

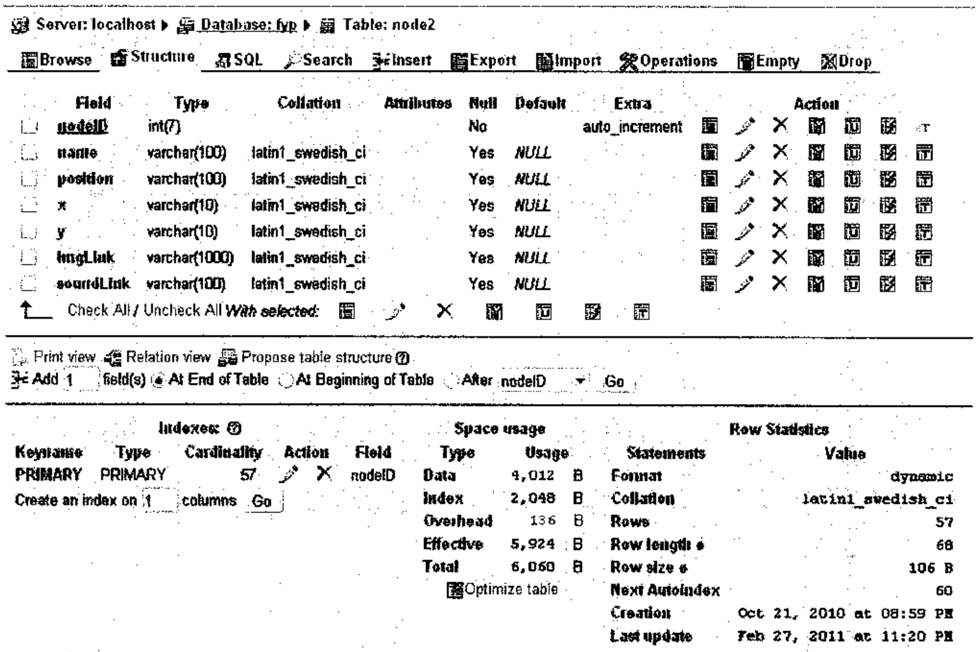
Figure 13: The Map for Location of Study

Based on Figure 13, the map is generated from Google Earth. The 'yellow pins' in the figure represent all the nodes. All relevant information of the nodes will be stored in the table "Node" in database.

4.4 Database Development

Database for the system is developed using phpMyAdmin. For this project, there are 3 relevant tables under the database, which are Node, Path and Feedback.

4.4.1 Node Table



Server: localhost ▸ Database: fyp ▸ Table: node2

Browse | Structure | SQL | Search | Insert | Export | Import | Operations | Empty | Drop

Field	Type	Collation	Attributes	Null	Default	Extra
nodeID	int(7)			No		auto_increment
name	varchar(100)	latin1_swedish_ci		Yes	NULL	
position	varchar(100)	latin1_swedish_ci		Yes	NULL	
x	varchar(10)	latin1_swedish_ci		Yes	NULL	
y	varchar(10)	latin1_swedish_ci		Yes	NULL	
imgLink	varchar(1000)	latin1_swedish_ci		Yes	NULL	
soundLink	varchar(100)	latin1_swedish_ci		Yes	NULL	

Check All / Uncheck All *With selected:*

Print view Relation view Propose table structure

Add 1 field(s) At End of Table At Beginning of Table After nodeID Go

Indexes:

Keyname	Type	Cardinality	Action	Field
PRIMARY	PRIMARY	57		nodeID

Create an index on 1 columns Go

Space usage

Type	Usage	
Data	4,012	B
Index	2,048	B
Overhead	136	B
Effective	5,924	B
Total	6,060	B

Optimize table

Row Statistics

Statements	Value
Format	dynamic
Collation	latin1_swedish_ci
Rows	57
Row length ø	68
Row size ø	106 B
Next Autoindex	60
Creation	Oct 21, 2010 at 08:59 PM
Last update	Feb 27, 2011 at 11:20 PM

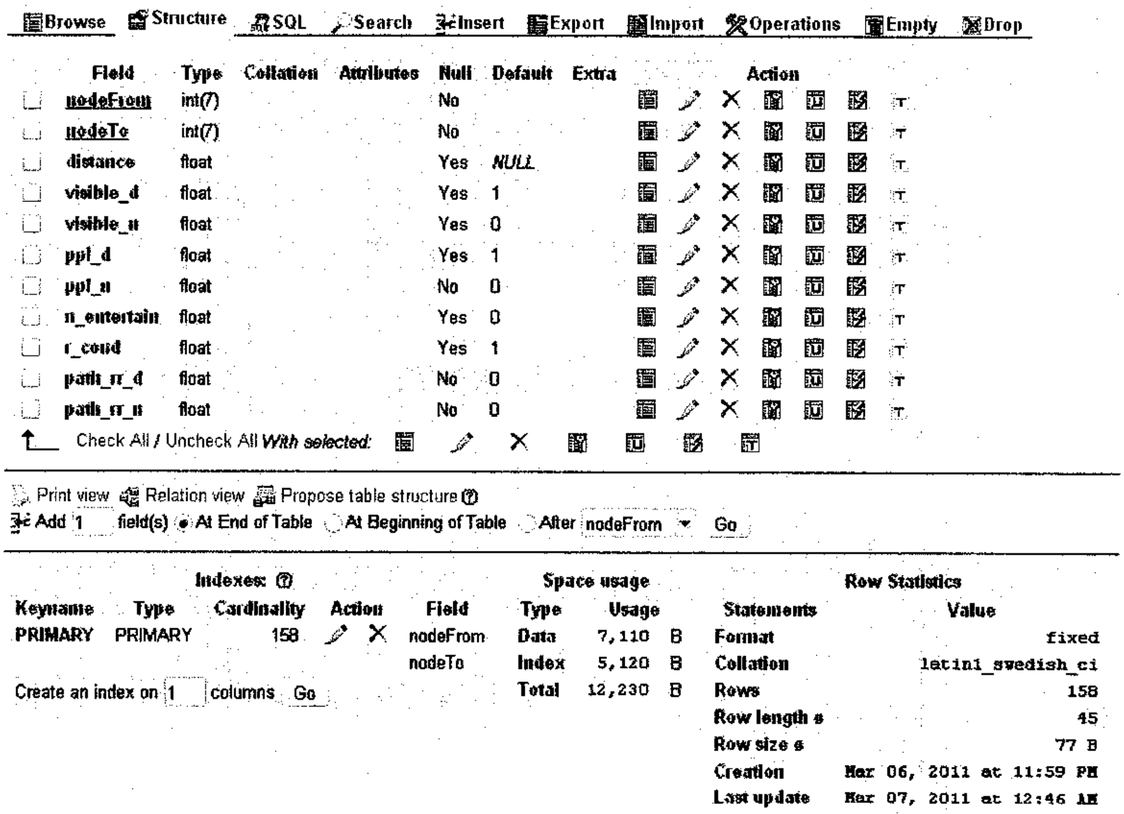
Figure 14 (a): Structure of Node Table

nodeID	name	position	x	y	imgLink	soundLink
0	Excel	N4 36'57.06 E101 07'18.50	NULL	NULL	NULL	NULL
1	Kinta City	N4 36'52.48 E101 07'13.30	NULL	NULL	NULL	NULL
2	Tesco	N4 36'59.40 E101 07'07.76	NULL	NULL	NULL	NULL
3	Nasi Kandar Nasmir	N4 36'59.26 E101 07'11.23	NULL	NULL	NULL	NULL
4	Spark Pub	N4 36'58.76 E101 07'11.96	NULL	NULL	NULL	NULL
5	AMGO	N4 36'58.57 E101 07'12.50	NULL	NULL	NULL	NULL
6	Infinity	N4 36'57.94 E101 07'13.20	NULL	NULL	NULL	NULL
7	Serendipity Shop	N4 36'57.61 E101 07'13.84	NULL	NULL	NULL	NULL
8	La Novel Slimming Centre	N4 36'57.14 E101 07'14.60	NULL	NULL	NULL	NULL
9	Perfect Image	N4 36'57.76 E101 07'15.16	NULL	NULL	NULL	NULL
10	Lady Spa Beauty	N4 36'55.46 E101 07'15.80	NULL	NULL	NULL	NULL
11	K-Ten	N4 36'55.94 E101 07'16.66	NULL	NULL	NULL	NULL
12	Sincero	N4 36'58.30 E101 07'10.41	NULL	NULL	NULL	NULL
13	Jiu Jiu Fu	N4 36'57.69 E101 07'10.92	NULL	NULL	NULL	NULL
14	Adelin Group	N4 36'57.03 E101 07'11.79	NULL	NULL	NULL	NULL
15	Fobs Solution	N4 36'56.65 E101 07'12.46	NULL	NULL	NULL	NULL
16	LED World	N4 36'56.26 E101 07'13.08	NULL	NULL	NULL	NULL
17	F1 Pub	N4 36'56.02 E101 07'13.58	NULL	NULL	NULL	NULL
18	Samsung Hp Service	N4 36'55.64 E101 07'14.14	NULL	NULL	NULL	NULL
19	Ting Feng	N4 36'55.28 E101 07'14.64	NULL	NULL	NULL	NULL
20	Satisfaction East	N4 36'54.78 E101 07'16.96	NULL	NULL	NULL	NULL
21	1919	N4 36'56.73 E101 07'09.66	NULL	NULL	NULL	NULL
22	Yess Beauty Box	N4 36'55.97 E101 07'10.82	NULL	NULL	NULL	NULL
23	YiShen	N4 36'55.45 E101 07'11.55	NULL	NULL	NULL	NULL

Figure 14(b): Example of Data Inserted in Node Table

Table "Node" stores information related to the node with nodeID serves as the identifier of each node. Node Table *nodeID* field is filled with auto-increment values, starting from zero and serves as primary key for the table. There are 57 records in the table, indicating there are 57 nodes on the map. *name* field gives a more meaningful description that identifies each record. The values of position are obtained from Google Earth, according to their coordinates on Earth.

4.4.2 Path Table



Browse | Structure | SQL | Search | Insert | Export | Import | Operations | Empty | Drop

Field	Type	Collation	Attributes	Null	Default	Extra	Action
nodeFrom	int(7)			No			
nodeTo	int(7)			No			
distance	float			Yes	*NULL*		
visible_d	float			Yes	1		
visible_n	float			Yes	0		
ppl_d	float			Yes	1		
ppl_n	float			No	0		
n_entertain	float			Yes	0		
r_cond	float			Yes	1		
path_rr_d	float			No	0		
path_rr_n	float			No	0		

Check All / Uncheck All *With selected:*

Print view Relation view Propose table structure

Add 1 field(s) At End of Table At Beginning of Table After nodeFrom Go

Indexes:

Keyname	Type	Cardinality	Action	Field
PRIMARY	PRIMARY	158		nodeFrom
				nodeTo

Create an index on 1 columns Go

Space usage

Type	Usage	
Data	7,110	B
Index	5,120	B
Total	12,230	B

Row Statistics

Statements	Value
Format	fixed
Collation	latin1_swedish_ci
Rows	158
Row length ø	45
Row size ø	77 B
Creation	Mar 06, 2011 at 11:59 PM
Last update	Mar 07, 2011 at 12:46 AM

Figure 15 (a): Structure of Path Table

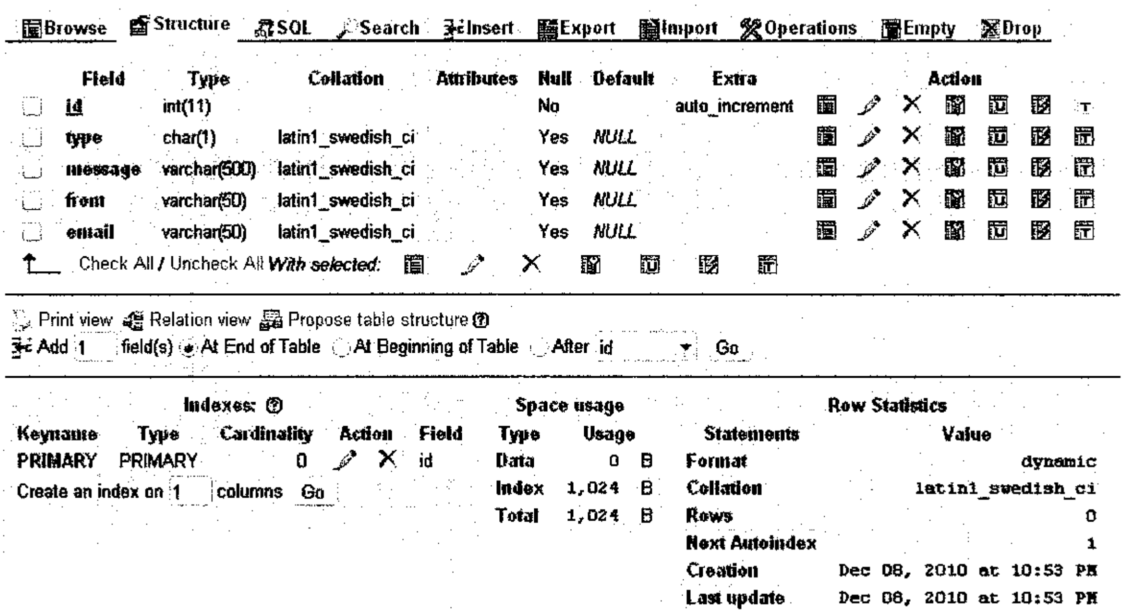
nodeFrom	nodeTo	distance	visible_d	visible_n	ppl_d	ppl_n	n_entertain	r_cond	path_rr_d	path_rr_n
26	18	36	0	1	0	1	0	0	0	0.55
1	46	90	0	1	0	1	0	0	0	0.55
1	38	40	0	1	0	1	0	0	0	0.55
2	21	103	0	1	0	1	0	0	0	0.55
2	3	105	0	1	0	1	0	0	0	0.55
2	12	85	0	1	0	1	0	0	0	0.55
3	12	62	0	1	0	1	0	0	0	0.55
3	4	27	0	1	0	1	1	0	0.25	0.8
4	3	27	0	1	0	1	1	0	0.25	0.8
4	5	17	0	1	1	1	1	0	0.5	0.8
5	6	22	0	1	0	1	1	0	0.25	0.8
5	4	17	0	1	1	1	1	0	0.5	0.8
30	31	29	0	1	0	1	0	0	0	0.55
6	5	22	0	1	0	1	1	0	0.25	0.8
6	7	28	0	1	0	1	1	0	0.25	0.8
6	15	68	0	1	1	1	1	0	0.5	0.8
7	6	28	0	1	0	1	1	0	0.25	0.8
7	8	24	0	1	0	1	0	0	0	0.55
7	16	69	0	1	1	1	0	0	0.25	0.55
8	7	24	0	1	0	1	0	0	0	0.55
8	9	23	0	1	1	1	0	0	0.25	0.55
30	29	26	0	1	0	1	0	0	0	0.55
9	8	23	0	1	1	1	0	0	0.25	0.55
9	10	24	0	1	1	1	0	0	0.25	0.55

Figure 15 (b): Example of Path Table

Table "Path" stores information related to the path with *nodeFrom* and *nodeTo* as the primary and foreign keys that relate to nodeID in table "Node". There are 158 records in this table, indicating there are 158 different interactions between the nodes. Distance between the nodes is calculated in unit meter by using Google Earth tools. *visible_d* and *visible_n, ppl_d, ppl_n, n_entertain, r_cont* are safety metrics involved in determining safest route. The values for these fields are obtained through observations. However, for fields like visible_n and ppl_n that take into consideration the visibility and amount of people at night are based on the time frame 8:00pm to 11:00pm as this is the most active period at night in that area. *path_rr_d* and *path_rr_n* are the risk rating of the path which are calculated in the following equations:

- path_rr_d = 0.3*r_visible_d + 0.25*ppl_d + 0.25*n_entertain + 0.2*r_cond
- path_rr_n = 0.3*r_visible_n + 0.25*ppl_n + 0.25*n_entertain + 0.2*r_cond

4.4.3 Feedback Table



Field	Type	Collation	Attributes	Null	Default	Extra	Action
id	int(11)			No		auto_increment	
type	char(1)	latin1_swedish_ci		Yes	NULL		
message	varchar(500)	latin1_swedish_ci		Yes	NULL		
from	varchar(50)	latin1_swedish_ci		Yes	NULL		
email	varchar(50)	latin1_swedish_ci		Yes	NULL		

Keyname	Type	Cardinality	Action	Field
PRIMARY	PRIMARY	0		id

Type	Usage	
Data	0	B
Index	1,024	B
Total	1,024	B

Statements	Value
Format	dynamic
Collation	latin1_swedish_ci
Rows	0
Next Autoindex	1
Creation	Dec 08, 2010 at 10:53 PM
Last update	Dec 08, 2010 at 10:53 PM

Figure 16: Structure of Feedback Table

Table “Feedback” stores information related to the feedbacks given by the users. There is no record at the moment.

4.5 System User Interface

4.5.1 Main Page

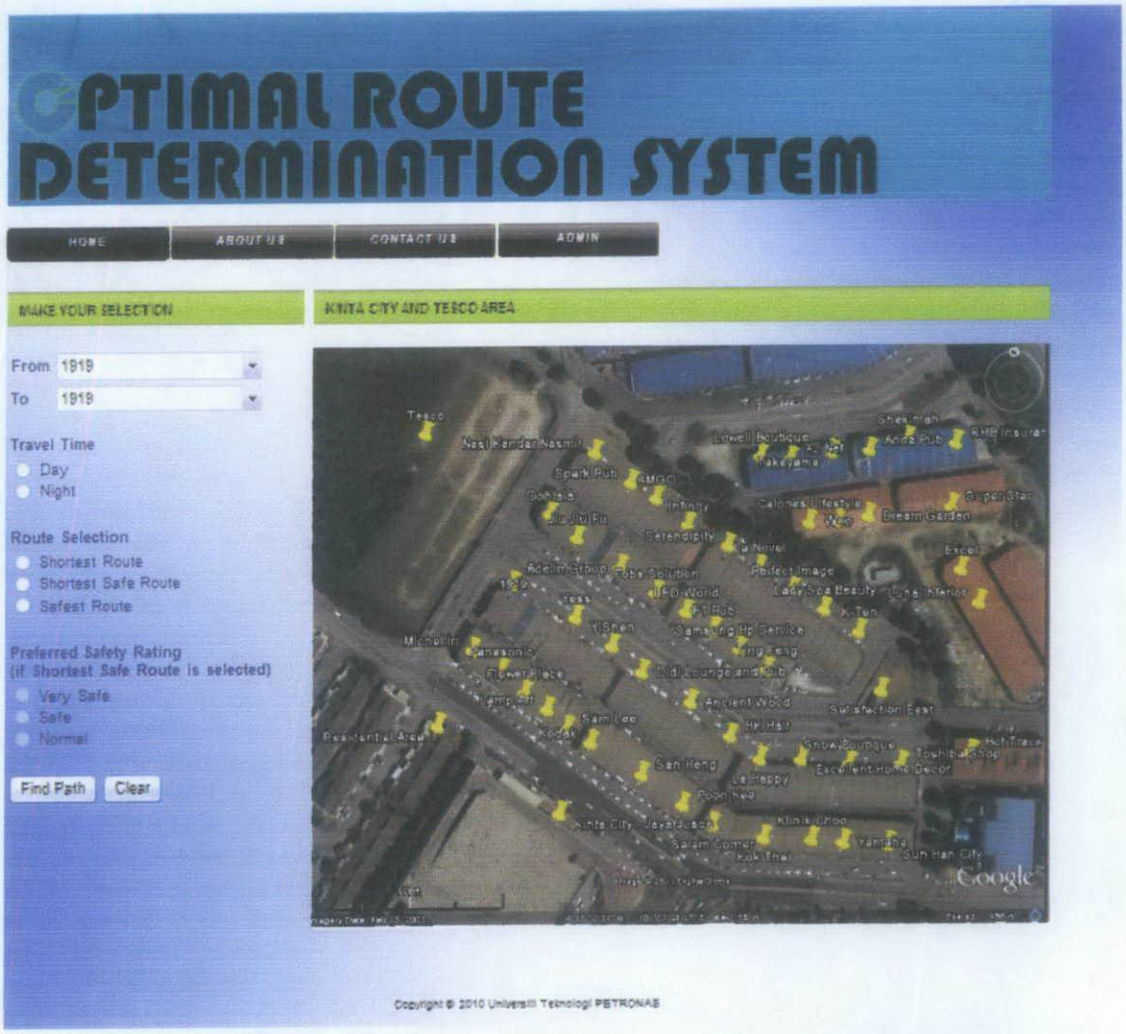


Figure 17: User Interface for Main Page

4.5.2 About Us Page

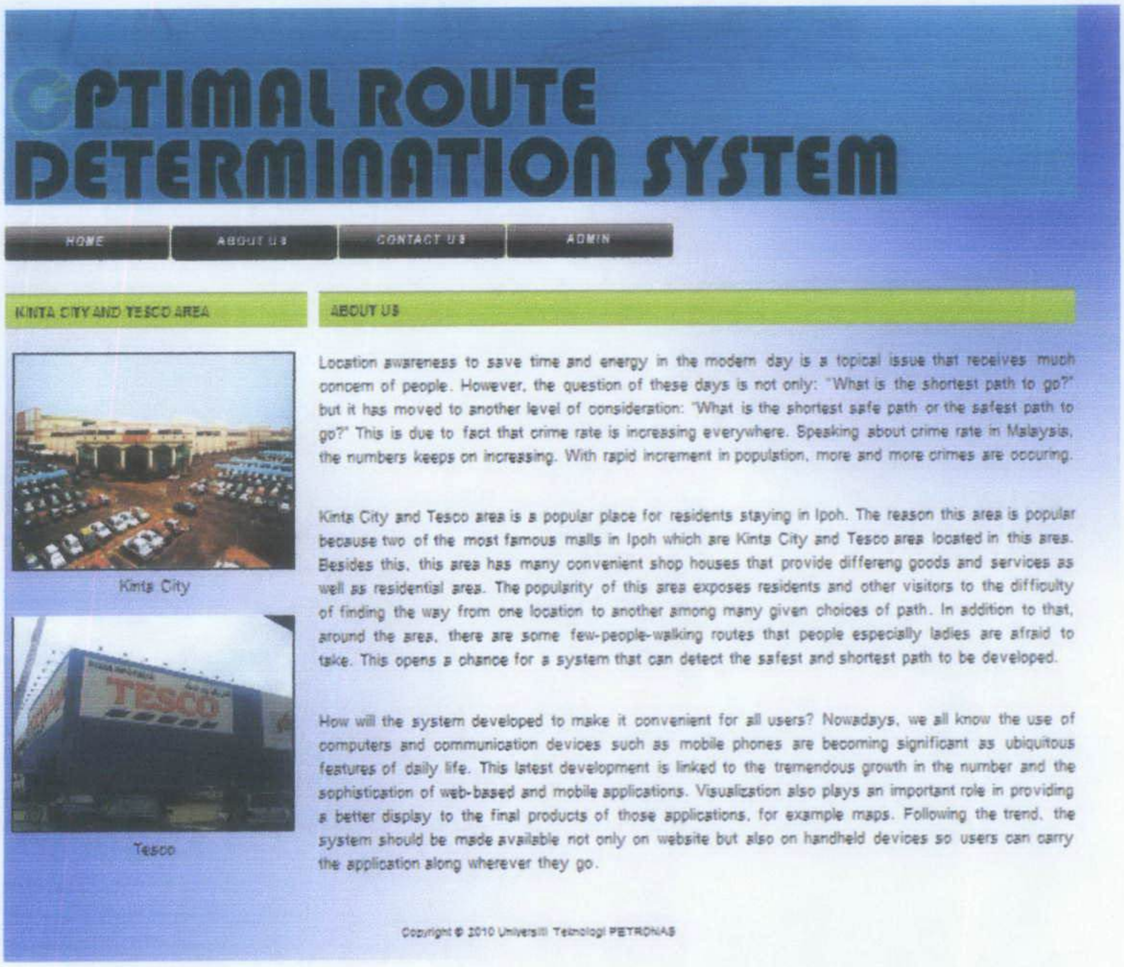


Figure 18: User Interface for About Us Page

4.5.3 Feedback Page

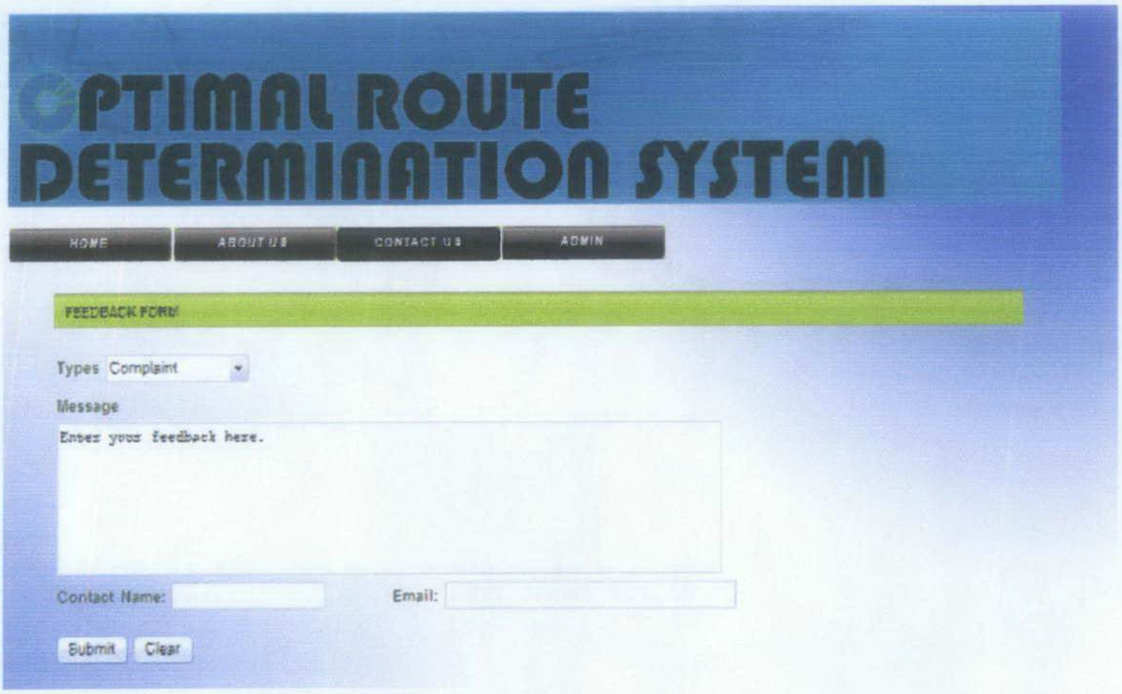


Figure 19: User Interface for Feedback Page

4.5.4 Administrator Page

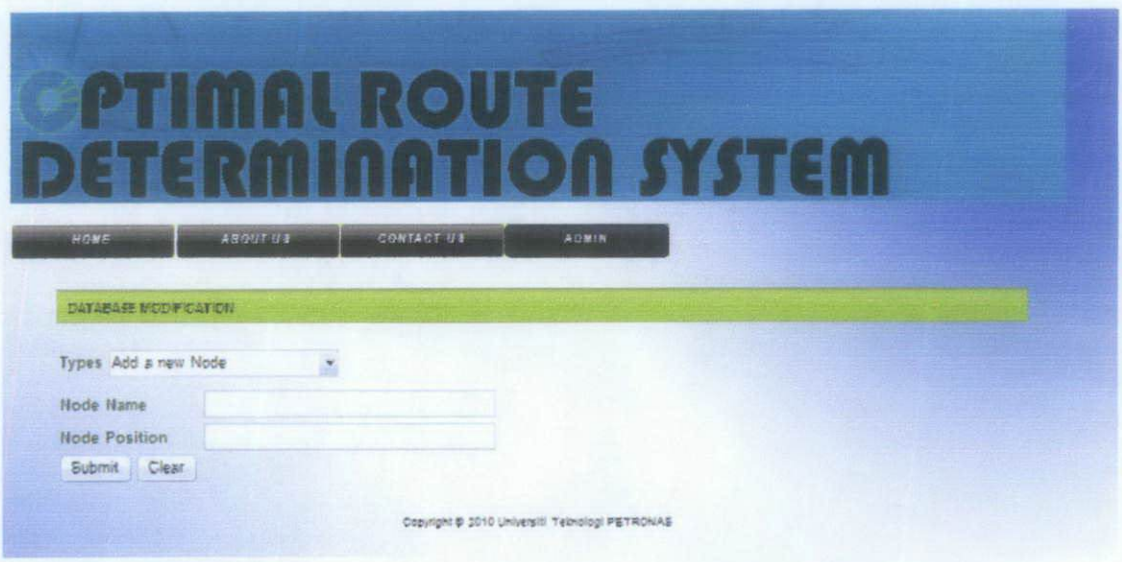


Figure 20: User Interface for Administrator Page

4.5.5 On Mobile Phone

Figure 21: User Interface on Mobile Phones

4.6 System Testing

4.6.1 Testing Methodology

The process of conducting the testing is described below:

1. Create test scenarios – The test scenarios include the start and end location where a pedestrian travels, the time of the day and the algorithm used.
2. Analyze expected result – Obtain opinions from experts (familiar with the area and travel in that area frequently) on the proposed safest route from their point of view.
3. Execute Testing – Run the system and get the result
4. Compare Results – Compare the result by observing the pattern between the suggested route from the system and the proposed route from the experts.

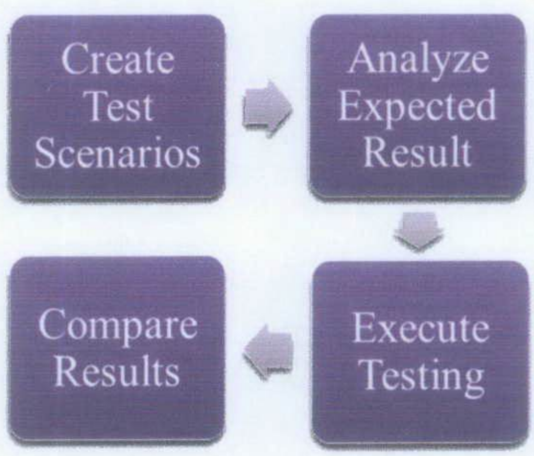


Figure 22: Testing Methodology

4.6.2 Test Scenarios and Test Result

Test Scenario #1

A pedestrian wants to know the safest route when he/she walks from Tesco to RHB Insurance on day time.

Tesco -> RHB Insurance [Day Time] [Safest Route Algorithm]

Expected Result:

Avoid using routes consist of Nasi Kandar Nasmir, Spark Pub, Amgo, Infinity and Oohlala as they are near entertainment district. During day time, routes from Adelin Group, Fobs Solution, LED World, F1 Pub and Samsung Hp Service should not be used as those routes have very less amount of people. During day time, the visibility of for shortcuts such as Yi Shen to Kodak and Infinity to Fobs Solution is not good. Furthermore, the route conditions at these shortcuts are in poor condition. They should not be taken as routes to travel to RHB Insurance.

Actual Result:

The total Risk Rating from **Tesco** To **RHB Insurance** is **0.80**.

The total distance from **Tesco** To **RHB Insurance** is **794.00** Meters .
Estimated walking time is: 11.91 Minutes.

THE PATH IS AS FOLLOW

- Tesco
- 1919
- Michellin
- Panasonic Shop
- Flower Place
- Lamp Art
- Sam Lee
- Kodak
- SenHeng
- Poon Kee
- Salam Corner
- Kok Thai
- Klink Choo
- Yamaha
- Sun Han City
- Toshiba Shop
- Snow Boutique
- Satisfaction East
- K-Ten
- Dream Garden Cafe
- Super Star Beauty School
- RHB Insurance

Discussion on Test Result:

Based on the actual result on this test scenario, the suggested route is almost similar to the expected result. It has avoided the usage of routes that are near to entertainment district. Although 1919 is also near to entertainment district, it is much further from other entertainment district compare to other routes. According to the suggested route, routes with very low amount of people are not taken as the risk of taking those routes is higher. Moreover, all shortcuts in the map are avoided in suggested route. Hence, we can say that the suggested route from the system is safe. However, the distance for the shortest route from Tesco to RHB Assurance is just 350 meters compared to the distance of the safest route 794 meters.

<u>Test Scenario #2</u>

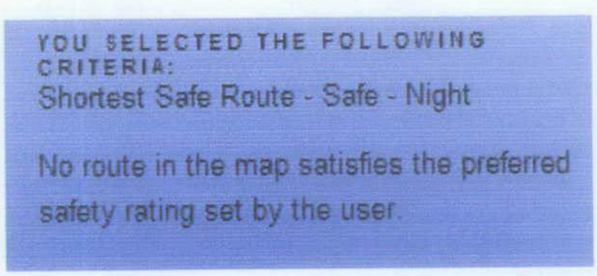
A pedestrian wants to know the shortest safe route when he/she walks from Sun Han City to Lowell Boutique at night. His/her preferred safety rating is 'Safe'.

Sun Han City -> Lowell Boutique [Shortest Safe] [Night][Safe]

<u>Expected Result:</u>

Safe requires a risk rating of less than 0.25. From Sun Han City to Lowell Boutique, the route should avoid routes that have high risks such as Didi Lounge and Pub, Ancient Wood, HK Hair. The safer route should start directly from Toshiba Shop. However it is possible that no route can fulfill the condition as most routes connected to Lowell Boutique, including Calories Lifestyle, X2 net are considered risky at night

<u>Actual Result:</u>



<u>Discussion on Test Result:</u>

There is no difference between the actual result and expected result. Hence, the system can be considered as reliable.

Test Scenario #3

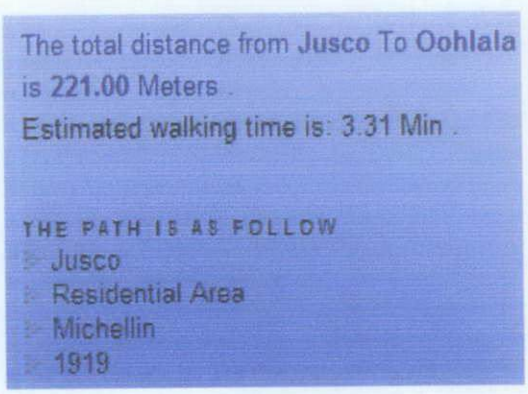
A pedestrian wants to know the shortest safe route when he/she walks from Jaya Jusco to Oohlala on day time. His/her preferred safety rating is 'Safe'.

Jaya Jusco -> Oohlala [Shortest Safe] [Day] [Safe]

Expected Result:

From Jaya Jusco to Oohlala, it is not difficult to fulfill the condition of 'Safe'. Safe requires a risk rating less than 0.25. For all the routes that are considered safe, the shortest route to reach the destination should be Sam Lee – Kodak – Lamp Art – Flower Place – Panasonic – Michellin – 1919 – Oohlala.

Actual Result:



Discussion on Test Result:

The suggested route given by the system is different from expected result. In fact, the system gives better suggested routes compared to the expected result. Residential Area, Michellin and 1919 are considered as routes that are safe. And it takes only 221 meters to reach the destination while the expected result (Sam Lee – Kodak – Lamp Art –

Flower Place – Panasonic – Michellin – 1919 – Oohlala) has a distance of (40+15+16+15+20+18+64+34) = 224 meters.

<u>Test Scenario #4</u>

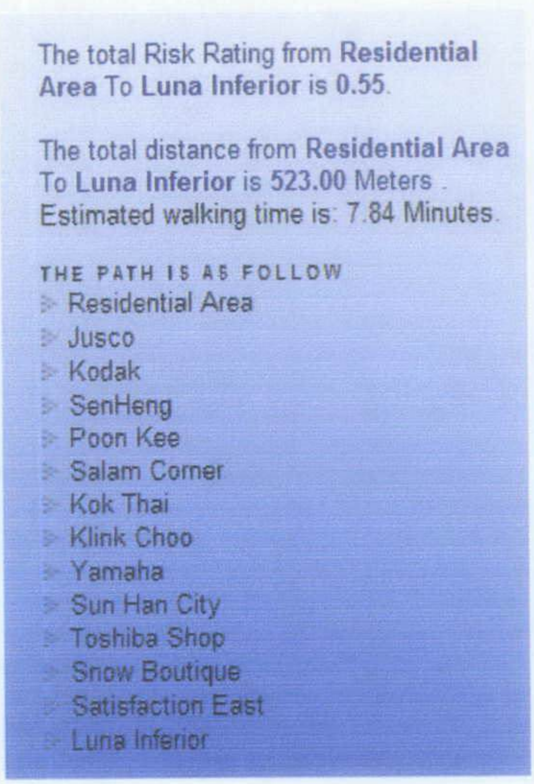
A pedestrian wants to know the safest route when he/she walks from Residential Area to Lune Exterior at night.

Residential Area -> Luna Exterior [Safest Route][Night]

<u>Expected Result:</u>

The path must avoid entertainment district and shortcuts. The safest path is most likely to be Kinta City – San Heng – Poon Kee – Salam Corner – Kok Thai – Klink Choo – Yamaha – Sun Han City – Toshiba Shop – Satisfaction East – Luna Inferior

<u>Actual Result:</u>



<u>Discussion on Test Result:</u>

The result is almost identical to the anticipated result, with the exception of route Jusco – Kodak and route Toshiba shop - Snow boutique. Thus, the result is considered accurate.

4.7 User Testing

4.7.1 Testing Methodology

The system is tested by 5 users. The users specify the routes and conditions they wish to test and enter the inputs into the system. The result that is returned by the system will be used by the users. The users will walk from the origin to destination using the route suggested by the system. After that, the users will give feedback and their opinions regarding to the result provided by the systems.

4.7.2 Test Result

None of them have faced any danger while travelling using the suggested route from the system. The feedbacks of the users are as following:

- When the question "Do you feel safer using the suggested route?" is being asked, 4 out of 5 users agreed that they felt safer while using the suggested route. However, one of them commented that the system makes no difference.
- One of the users commented that she feels more confident when travelling the route. She thinks the system is trustable.
- There are 3 users who commented that the user interface of the system is not friendly enough.
- In general, the users are satisfied with the routes suggested by the system.

4.8 Discussion

4.8.1 Test Results

Safety refers to the condition of being protected from or unlikely to cause danger, risk or injury. It is difficult to measure safety and safety is very subjective. Each person has different perception and interpretation towards the degree of safety. From the system test result, the actual result is close to the expected result. This could indicate that the algorithm of the system is working well. On the other hand, all of the users are safe when using the suggested route during the user testing. However, it is not valid to prove anything as incidents such as pick pocket and robbing occur by chance. Anyway, based on the feedbacks given by the users, 80% of them are satisfied with the route suggested by the system and they feel safer when using the route. From their comments, we can accept that the system is reliable in general.

4.8.2Accuracy of the System

In this system, only 4 safety metrics are included in constructing the safest route algorithm. Therefore the system has its limitation in achieving perfect accuracy. One way of improving its accuracy is by including safety metric such as crime rates and accident rates. However, as mentioned in *section 4.2.2,* the information for crime rates and accident rates are not readily available in Malaysia. Malaysia has statistics for crime rates and accident rates only over a large region, but the system requires crime rates and accident rates information on each path between 2 nodes. The information is not feasible to obtain currently, therefore crime rate and accident rate factors are not included as safety metrics in this project.

The weight used for the safety metrics are not constant and they are subjected to change s in the future. Human perception changes over time and 'hot spots' for crimes will change accordingly. Therefore, the weight of each safety metrics are dynamic and should be revised from time to time to make sure that it is in line with the current trend.

It is undeniable that the system has limitation on accuracy of the system. Nevertheless, the algorithm used in this system serves as a basis to determine the safest route. The accuracy and reliability of the system can be further enhanced in the future by adding more nodes, paths and additional safety metrics in it.

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This project achieves its objectives by incorporating safest route algorithm that is based on established safety metrics in Optimal Route Determination System (ORDS). By conducting research on appropriate safety metrics, information on how people define safety in pedestrians' point of view can be obtained. This information serves as a basis to the construction of safest route algorithm used in the system. With safest route algorithm that is based on established safety metrics, the system becomes more reliable in generating the safe routes to the users.

The safest route algorithms proposed in this project is not perfect and has its limitations. It could still be further enhanced to improve its reliability and accuracy. Nevertheless, this algorithm serves as a fundamental basis which could be further improved in the future.

5.2 Recommendation

Although the objectives of the project are achieved, there is still space of improvements for the system. The following are some of the ideas that will improve the system/algorithm but cannot be implemented due to time constraints:

- Add weather as another factor in determining safety of a route – The algorithm currently takes into consideration of day/night factor in determining route safety. It will be better to the users if the algorithm takes weather factor such as rain, snow or cloudy into consideration in determining safest route.
- Expand the system to cover a larger area or another area – The scope of the project currently covers only the Kinta City and Tesco area. The system can cover a larger area or a different area using the same proposed algorithm to give users suggestions on using safer route.
- Explore and research additional safety metrics that can affect the safety of pedestrians – the accuracy and reliability of the system can be improved by including more safety metrics to determine the route safety. In the future when information is more readily available, some of the excluded safety metrics mentioned in this project may be feasible to be included into the algorithm.

CHAPTER 6

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CHAPTER 7

APPENDICES

Appendix I – Result of Research Conducted By University of Southampton

Crime type	Treated area		Control area	
	Before	After	Before	After
a theft of vehicle				
b theft from vehicle	8	6		2
c attack/assault	2	1	1	
d theft bicycle	2	1		
e burglary			1	1
f attempt break-in	5		1	1
g milk stolen	3	5	3	
h theft outside	3		3	
i damage property	3			
j theft person			1	
k attempt theft	1	1		
l vandalism	11	8	2	
m other	1	1	1	
Total	39	25	13	4
(reported to police)	(5)	(5)	(3)	(1)
Day	7	10	4	0
Dark	23	9	4	2
D/K	9	6	5	2
'Likely' crimes				
Day	6	9	4	0
Dark	17	8	3	1
D/K	8	6	3	1
Total	31	23	10	2
Possibly	8	2	3	2

Table 5: Results of the Research Conducted by University of Southampton

Appendix II – Information Related to Mobile Technology

[26]

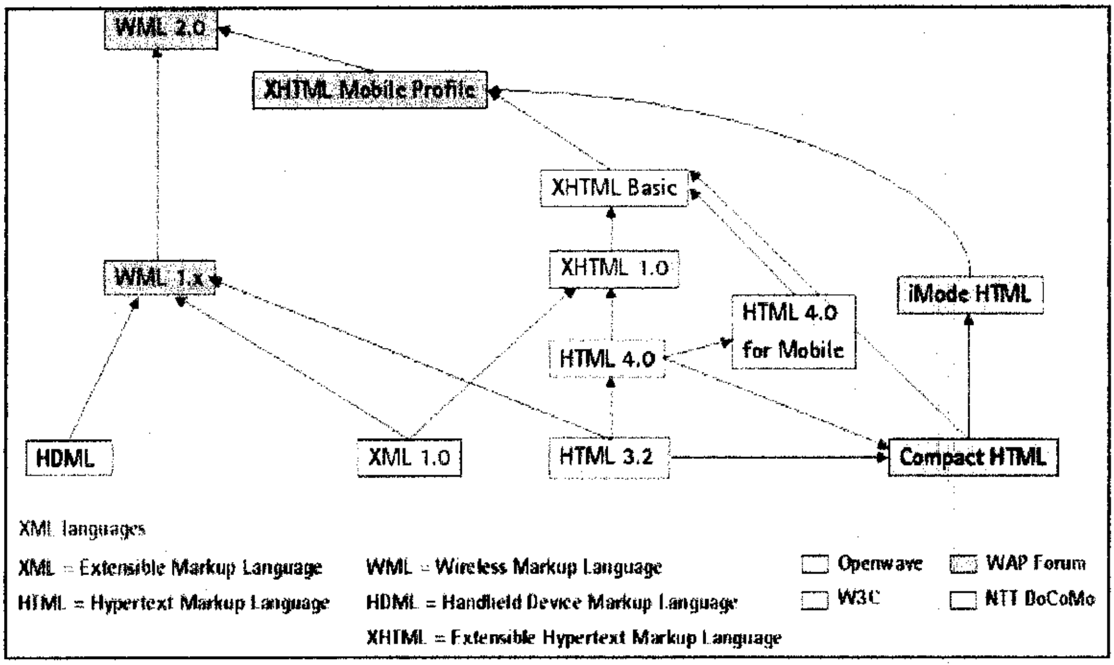

Figure 23: Relationship between Markup Languages

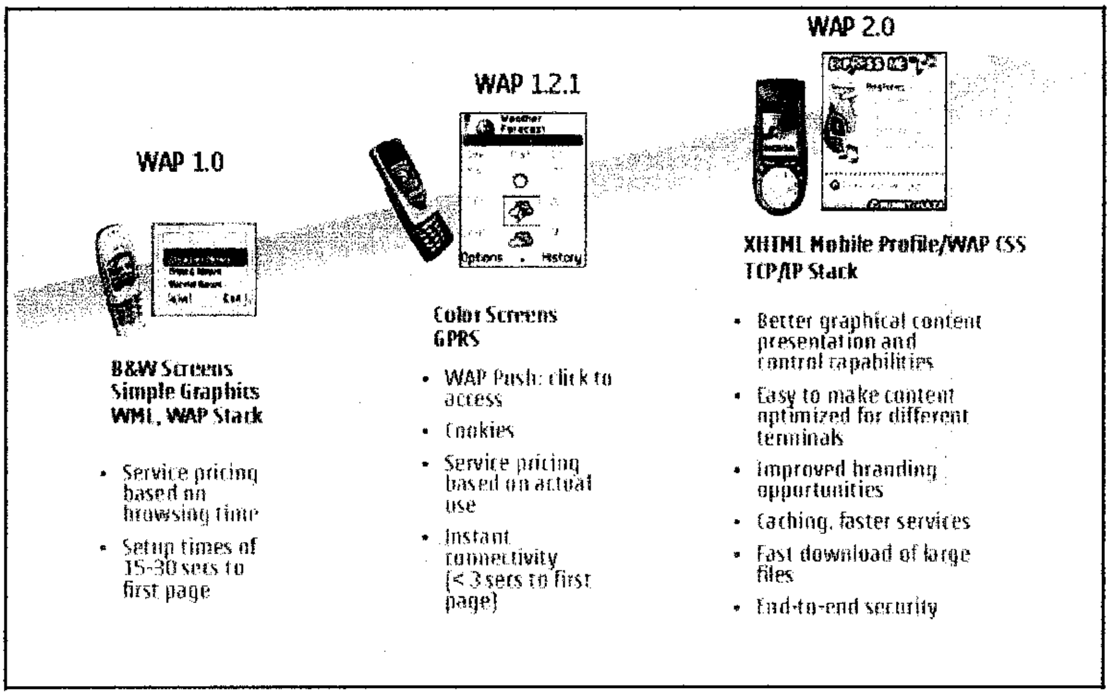

Figure 24: Evolution of Mobile Browsing

Appendix III – Sample Questionnaire/Survey

Survey for Final Year Project

Background:

One of the objectives of my project is to research the safety metrics that affect a route's safety. This survey is to gather information regarding to the safety problems on the routes around Kinta City and Tesco area. Thank you for your time.

1. How often do you go to Kinta City and Tesco area? (Including the areas around Kinta City Mall and Tesco)

[ ] Few times a week [ ] Once a week [ ] Few times a month

[ ] Once a month [ ] Others: ______________

2. Do you think that area is dangerous for pedestrian?

[ ] Yes [ ] No

3. Please rate the following safety metrics according to how it affects a route's safety in pedestrian's point of view.

Safety Metrics	1 (not important)	2 (less important)	3 (important)	4 (very important)	5 (critical)
Visibility (Good lighting condition, bright)					
Amount of People (crowded, very few people)					
Near Entertainment District (Clubs, Cyber cafes, Disco)					

4. In your opinion, are there any other factors that affect a route's safety?

____

Appendix IV – Algorithm Proposed by Mr. Yew

F. Brief Description of Invention and Claims (please attach documents):

The invention is a computer implemented design that guides pedestrian to relatively safe route.
The design introduces parameters and calculations use to rate safety of a node/point on map qualitatively.
The design proposes algorithm to include or omit node for shortest route determination.

Claim 1: Safety parameter and calculation

There are two sets of qualitative parameters:

a. User risk preference parameters
b. Path safety rate parameters (stored in database)

For user risk preference, the following qualitative parameters are used:

Data type	Parameter	Description
Nominal	wall_lit	Does the user care if the path is well lit? Input: Either Yes (enumerated by value 1) or No (enumerated by value 0)
	is_paved	Does the user care if the path is paved? Input: Either Yes (enumerated by value 1) or No (enumerated by value 0)
Ratio	low_crime_rob low_crime_assault low_crime_rape low_crime_kidnap	What is the expected risk that user willing to take? Input: A decimal value in the range [0,1] where the extremes 0 represents high crime rate and 1 represents low crime rate.

For path safety rate, the following qualitative parameters are used:

Data type	Parameter	Description
Nominal	dwell_lit	Is the path well lit? Answer: Yes or No. Enumerated by 0 or 1.
	dis_paved	Is the path paved? Answer: Yes or No. Enumerated by 0 or 1.
Ratio	dlow_crime_rob dlow_crime_assault dlow_crime_rape dlow_crime_kidnap	Is the path having low crime rate? Answer: Valued [0,1] derived from statistical data using following calculation: Suppose, R = rate of crime* per period R_{mean} = mean rate* of crime per period If R greater than R_{mean}, set parameter scale to 0.0 Else If R equals R_{mean}, set parameter scale to 0.25 Else If R less than R_{mean} but R is not 0, set parameter scale to 0.75 Else R is set to parameter scale 1.0 Note: * geography specific * crime is replaced by robbery, assault, rape or kidnap

Figure 25a: Algorithm Proposed by Mr. Yew (part 1)

Claim 2: algorithm to include safe path from computation

The algorithm will traverse all the paths in the database and determine which paths are fit. Path that fulfills required safety criteria is labeled as fit and added to the safe path list. At the end of the traversal, the list will be submitted for route computation. Only paths in the fit list are considered. The rest not included are simply ignored. The algorithm steps are as follows:

Step 1:
Create empty fitPath_List.

Step 2:

System accepts user's risk preference from direct input
= {well_lit, is_paved, low_crime_rob, low_crime_assault, low_crime_rape, low_crime_kidnap}
= {well_lit, is_paved} U {low_crime_rob, low_crime_assault, low_crime_rape, low_crime_kidnap}
= user_NSet U userRSet

Complement each element of user_NSet
user_NSet = ~user_NSet

Represent all the sets as diagonal matrices:
(user_NSet) = [well_lit 0; 0 is_paved]
(user_RSet) = [low_crime_rob 0 0 0; 0 low_crime_assault 0 0; 0 0 low_crime_rape 0; low_crime_kidnap 0 0 0]

Step 3:
System establishes connection to database of paths of the map.
The algorithm initially traverses through all paths $P = \{P_0, P_1, P_2, \ldots, P_n\}$ of the digital map in database to retrieve the mirror sets of both user_NSet and user_RSet i.e. db_NSet and db_RSet.

For each path, represent all the sets as diagonal matrices:
(db_NSet) = [dwell_lit 0; 0 dis_paved]
(db_RSet) = [dlow_crime_rob 0 0 0; 0 dlow_crime_assault 0 0; 0 0 dlow_crime_rape 0; dlow_crime_kidnap 0 0 0]

Step 4:
Do element-wise OR operation on user_NSet and db_NSet
A = (user_NSet) | (db_NSet)

Do relational operations on user_RSet and db_RSet
B = (db_RSet) >= (user_RSet)

Step 5:
A and B are both square matrices. Retrieve the diagonal elements of each and place in row matrices A1 and B1 respectively.

```
for(i=0;i<column size(A);i++)
for(j=0;j<row size(A);j++)
if(i==j)A1[i]=A[i,j]

for(i=0;i<column size(B);i++)
for(j=0;j<row size(B);j++)
if(i==j)B1[i]=A[i,j]
```

Step 6:
Multiply all elements in A1, $ProdA = \sum A1[i]$

Multiply all elements in B1, $ProdB = \sum B1[i]$

Multiply the results, Fitness = ProdA x ProdB

If Fitness>0, add the path into fitPath_List.

Check if there is anymore path in database. If yes, go back to step 3. Else, pass fitPath_List to a shortest route algorithm.

Figure 25b: Algorithm Proposed by Mr. Yew (part 2)

Appendix V – Gantt Chart

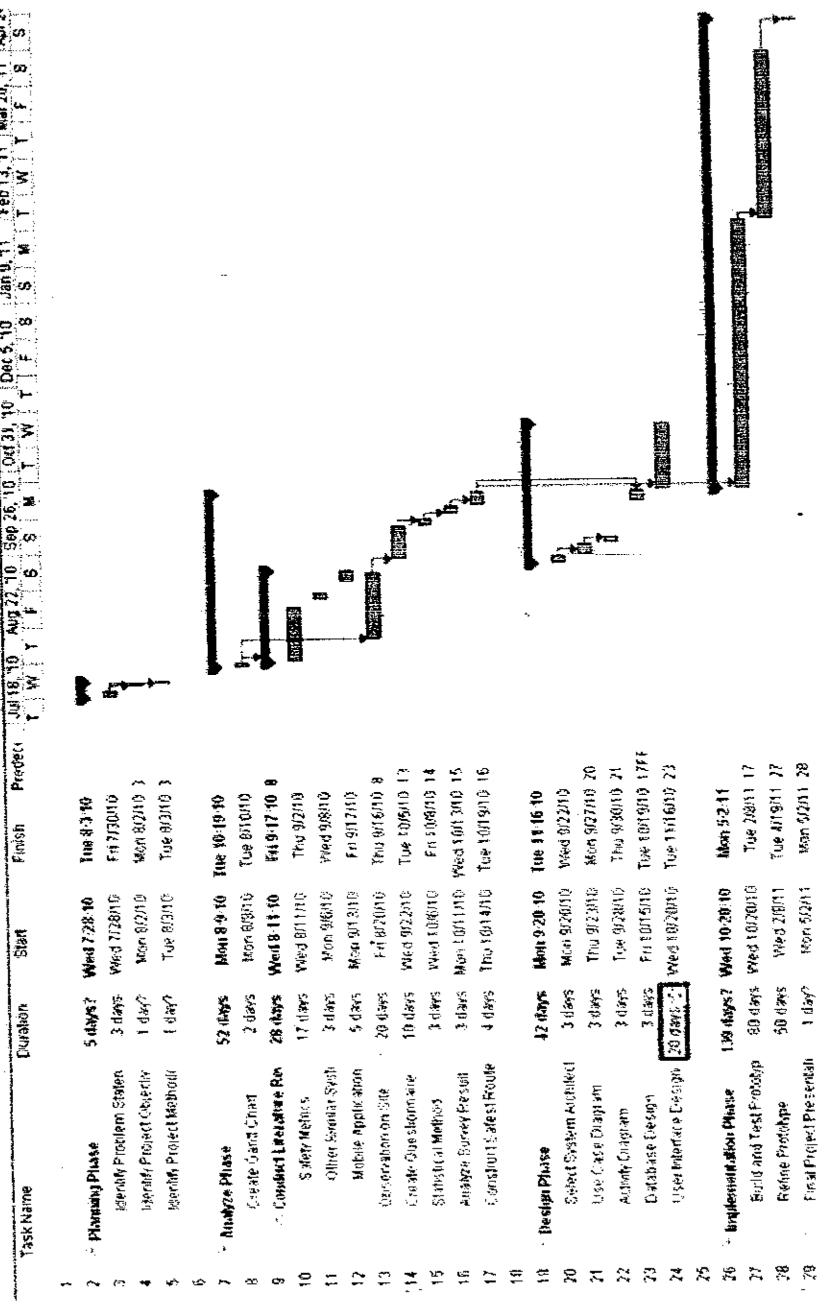

Figure 26: Project Gantt Chart